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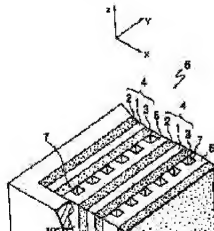
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(54) FUEL BATTERY

(57)Abstract:

PURPOSE: To simplify a feeding system while simplifying the structure, to maintain high efficiency, and to achieve reduction in the size by feeding liquid fuel perpendicularly to the stream of oxidant gas when the liquid fuel and the oxidant gas are fed to a stack, in which a plurality of electromotive parts having electrolyte plates are piled up.

CONSTITUTION: An electromotive part 4 comprises a fuel electrode 2 which is an anode, an oxidant electrode 3 which is



a cathode, and an electrolyte plate 1 sandwiched between them. The fuel electrode 2 and the oxidant electrode 3 are formed of conductive porous body so that a gas such as the fuel and the oxidant as well as electrons can be channeled therein. A plurality of the electromotive parts 4 are formed through a separator 5, to form a stock 6, which become a battery main body. The separator 5 is also formed of conductive material so that it can function as a collecting plate for passing electrons thus generated. In this structure, the oxidant gas is channeled from the lower part to the upper part of the stock 6, and the stream is smoothed by using the heat generated by battery reaction, A plurality of feeding grooves 7 for flowing the gas vertically are provided on the surface of the separator 5 abutting on the oxidant electrode 3.

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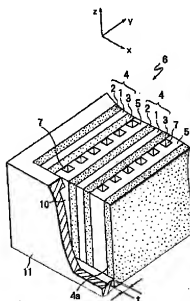
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(54)【発明の名称】 燃料電池

(57)【要約】 (修正有)

【目的】 液体燃料と酸化剤ガスの供給システムを簡易化し、構造を簡素化し、高効率を維持し、小形化する。

【標記】 燃料極2、酸化剤極3およびこれら両電極2、3に挟持された電解質層を有する起電部4を複数個積層したスタック6を備え、燃料として液体燃料を用いた燃料電池において、スタック6の外周面のうち、燃料極の端面を含み、かつ垂直方向に流す酸化剤ガスの流れと平行に配置された少なくとも一つの面に沿って、酸化剤ガスの流れと直交するような方向に、起電部4構成部品の端面に液体燃料が直接接する液体燃料導入路を設け、液体燃料導入路内の液体燃料は毛管力により燃料極に供給される燃料電池。



【特許請求の範囲】

【請求項1】 燃料極、酸化剤極およびこれら両電極に挟持された電解質板を有する起電部を複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、

前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも一つの面に沿って、前記酸化剤ガスの流れと直交するような方向に、前記燃料極の端面に前記液体燃料が直接接する液体燃料導入路を設け、前記液体燃料を前記燃料極となる多孔質体の毛管力で前記燃料極に供給するよう構成したことを特徴とする燃料電池。

【請求項2】 前記燃料極の前記酸化剤極と接する面に、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設けられていることを特徴とする請求項1記載の燃料電池。

【請求項3】 前記酸化剤極に、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設けられていることを特徴とする請求項1記載の燃料電池。

【請求項4】 前記液体燃料は、前記液体燃料導入路の毛管力で燃料貯蔵タンクから導入されることを特徴とする請求項1記載の燃料電池。

【請求項5】 前記液体燃料を前記燃料極に毛管力で供給する毛管部の表面には、酸化被膜が形成されていることを特徴とする請求項1記載の燃料電池。

【請求項6】 前記燃料極は、耐熱耐酸性の担持体上に概ね互いに重ならないで島状に燃料酸化触媒を存在させ、少なくとも前記燃料酸化触媒の表面に耐熱耐酸性のプロトン伝導性物質を存在させた燃料酸化触媒粒子により構成されていることを特徴とする請求項1記載の燃料電池。

【請求項7】 燃料極、酸化剤極および両電極に挟持された電解質板を有する起電部をセパレータを介して複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、

前記セパレータの前記酸化剤極と接する面に、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設け、かつ、前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも一つの面に沿って、前記酸化剤ガスの流れと直交するような方向に、前記燃料極の端面に前記液体燃料が直接接する液体燃料導入路を設け、前記酸化剤ガスを前記酸化剤ガス供給溝を介して供給すると共に、前記液体燃料を前記燃料極となる多孔質体の毛管力で、該燃料極に供給するよう構成したことを特徴とする燃料電池。

【請求項8】 前記セパレータの前記燃料極と接する面に、前記液体燃料導入路に向けて一端が開口された液体

燃料供給溝を設けられていることを特徴とする請求項7記載の燃料電池。

【請求項9】 前記液体燃料は、前記液体燃料導入路の毛管力で燃料貯蔵タンクから導入されることを特徴とする請求項7記載の燃料電池。

【請求項10】 前記液体燃料を前記燃料極に毛管力で供給する毛管部の表面には、酸化被膜が形成されていることを特徴とする請求項7記載の燃料電池。

【請求項11】 前記燃料極は、耐熱耐酸性の担持体上に概ね互いに重ならないで島状に燃料酸化触媒を存在させ、少なくとも前記燃料酸化触媒の表面に耐熱耐酸性のプロトン伝導性物質を存在させた燃料酸化触媒粒子により構成されていることを特徴とする請求項7記載の燃料電池。

【請求項12】 燃料極、酸化剤極およびこれら両電極に挟持された電解質板を有する起電部を複数積層したスタックを具備する燃料電池において、前記スタックは、その少なくとも積層方向がゴム弾性を示す材料で締め付けられていることを特徴とする燃料電池。

【請求項13】 燃料電池が、主として燃料極と酸化剤極およびこれら両電極に挟持された電解質層からなる起電部、燃料を前記起電部に供給する燃料供給手段および前記起電部の酸化剤極において発生した水の回収手段から構成されおり、前記水回収手段は酸化剤極に接して設けられた酸化剤極から生じる水を吸収する第1の水吸収手段と、前記第1の水吸収手段に接して設けられた第1の水吸収手段が吸収保持する水を吸収する第2の水吸収手段からなり、前記第2の水吸収手段は前記第1の水吸収手段よりも水吸収能力が大となるように設定されていることを特徴とする燃料電池。

【請求項14】 小型燃料電池、燃料極と酸化剤極およびこれら両電極に挟持された電解質層からなる起電部が複数個、接続導体により直列に接続され、各起電部の燃料極に共通の燃料通路から燃料が供給され、かつ各起電部の燃料極の電極面が前記燃料通路に面している構造を有しており、前記電解質層が吸水性物質または保水性物質を含有していることを特徴とする燃料電池。

【請求項15】 燃料極と酸化剤極およびこれら両電極に挟持された電解質層からなる燃料電池において、前記燃料電池は燃料極をアノードに分離させた機構を備えていることを特徴とする燃料電池。

【発明の詳細な説明】

【0001】

【発明の技術分野】本発明は、燃料電池、特に小型化に適した燃料電池に関する。

【0002】

【従来の技術】燃料電池は、単独の発電装置としては効率がいいことから最近注目されている。燃料電池は、燃料としてガスを使用するリン酸型燃料電池、溶融炭酸塩型燃料電池、固体電解質型燃料電池、アルカリ性電解液

型燃料電池等と、燃料として液体を使用するメタノール燃料電池、ヒドोज燃料電池等とに大別される。これらの燃料電池は、主に電力用発電機や大型機器を動かすための動力源を対象にしているため、ガスや液体の燃料、あるいは酸化剤ガスを電池内に導入するためのコンプレッサやポンプ等が必要であり、システムとして複雑であるばかりでなく、これらの導入のために電力を消費する。

【0003】液体燃料としてメタノールを用いたメタノール燃料電池を例として説明すると、メタノール燃料電池のシステムでは、燃料はメタノールタンクからポンプで電池本体に送られ、また酸化剤である空気はブロウにより電池本体に送られる。特にこの電池では、溶解燃料として、燃料となるメタノールと電解質である例えば希硫酸との混合液体を、メタノール制御器や酸制御器を介してポンプで電池本体に圧送するため、そのシステムは一部複雑になっている。このような複雑さは他の燃料電池についても同様で、いずれのシステムでも燃料や酸化剤ガスを送るためにブロウやポンプが必要となる。このようなシステムの複雑さは、現在の燃料電池が電力用や大型機器の動力源等として、大容量の電力を対象にしているためであり、これを達成するために大量の燃料や酸化剤ガスを流さなければならず、よってポンプやブロウ等が必要となる。

【0004】一方、社会的な動向として、OA機器、オーディオ機器、無線機器等の各種機器は、半導体技術の発達と共に小型化され、さらにポータブル性が要求されている。このような要求を満足するための発電源としては、手軽な一次電池や二次電池等が使用されている。しかし、一次電池や二次電池は、機能上使用時間に制限があり、このような電池を用いたOA機器等では当然使用時間が限定される。これらの電池を使用した場合、電池の放電が終わった後に、電池を交換してOA機器等を動かすことができるものの、一次電池はその重量に対して使用時間が短く、ポータブルな機器には向きである。また、二次電池では放電が終わると充電できる半面、充電のために電源が必要で使用場所が制限されるのみならず、充電に時間がかかるという欠点がある。特に、二次電池を組み込んだOA機器等では、電池の放電が終わっても電池を交換することが困難なため、機器の使用時間の制限はまねがれない。このように、各種小型機器を長時間動作させるには、従来の一次電池や二次電池の延長では対応が難しく、より長時間の動作に向けた電池が要求されている。

【0005】このような問題の一つの解決策として、上述したような燃料電池がある。燃料電池は、燃料と酸化剤を供給するだけで発電することができるという利点を有するだけでなく、燃料を交換し続けられ連続して発電できるという利点を有しているため、小型化ができれば消費電力が小さいOA機器等の小型機器の動作に極めて有利

なシステムといえる。

【0006】燃料電池は、酸化剤として空気が使用できるため、酸化剤の観点からは使用場所や使用時間等に制限を受けることはないが、燃料としてガスを使用する場合は、OA機器等の消費電力が小さいとはいえ、ガスの密度を考えると発電に要するガス量は大きく、電池の小形化には不向きである。これに対して、液体燃料はガスに比べると密度が高く、小型機器用燃料電池の燃料としては圧倒的に有利である。従って、液体燃料を用いた燃料電池が小型化できれば、従来にない長時間動作が可能な小型装置用の電源が実現できる。このような小型装置用電源を実現する上での障害は、前述したように、従来の液体燃料を用いたシステムでは、液体燃料を電池本体に送り込むためにポンプが、また酸化剤ガスを送り込むためにブロウ等が必要であるため、システムとしては複雑で、このままの構造では小型化することが困難なことにある。

【0007】さらに、リン酸型燃料電池や溶融炭酸塩型燃料電池、さらに固体電解質型燃料電池等の従来の燃料電池においては、ポンプやブロウで電池に供給されたガスは、酸化剤極と燃料極に隣接して設けられたガスチャンネルを通して各電極に導入される。この場合、大量の燃料ガスと酸化剤ガスをポンプやブロウに負荷をえないように流すという観点から、ガスチャンネルのガス流路はできるだけ圧損が生じないように大きな溝形状にしてある。例えば、溶融炭酸塩型燃料電池のガスチャンネルでは、通常 2mm を超えるような深さの溝が形成される。このことは、メタノール燃料電池のような液体燃料を用いる燃料電池でも同じであり、特にメタノール燃料電池では、上述したリン酸型燃料電池等とは異なり、電解質層および燃料極に電解質である例えば硫酸と燃料になるメタノールとの混合体を流すため、圧損に関してはガスを燃料とする場合よりさらに大きな値となる。このように、従来の燃料電池は、ポンプやブロウでガスや液体を送り込むために、ガスチャンネルの溝形状を大きくせざるを得ず、逆に溝形状を小さくするとポンプやブロウが大きくなる等、これまでの技術の延長では小型化は達成できないという問題がある。

【0008】上述したような点に対処し、小型化への対応を図った燃料電池として、液体燃料の供給に毛管力を利用した液体燃料電池（特開昭59-66066号公報参照）が提案されている。この液体燃料電池は、紙、木綿、アスベスト、ガラス等の有機あるいは無機繊維材料や、アクリル、ナイロン等の合成繊維を基材とした毛管材料の毛管力で、液体燃料を下部に設けた燃料貯蔵室から上部に向って一方に吸い上げてアノードに供給し、かつ酸化剤ガスを燃料の供給方向と同じ方向に流す平行流式の電池である。この電池では、燃料貯蔵室を下部に設けると共に、酸化剤ガスを垂直方向に流すために電池の下部にはガスの取入れ口が必要であり、従って燃料貯蔵室

とスタック底面との間に隙間を設けた構造となっている。またこの方式では、毛細管材料の一部を機械的に絞り込んで燃料の供給を制御できるように、その構成材料は上述したような柔軟性のある繊維で構成されている。さらにこの電池は、上述したような電気的に絶縁性の材料で構成した毛細管材料がアード側集電体の一部に、集電体と密着するように埋め込まれた構造となっている。

を図ろうとする燃料電池には適さない。

電圧を確保している。この構造はリン酸型燃料電池に限らず、溶融炭酸塩型燃料電池、さらに固体高分子電解質型燃料電池などにも応用されている。このような構造の燃料電池においては、ポンプやブロワなどを用いて電池に供給された燃料もしくは酸化剤としての空気は、酸化剤極板と燃料極板に隣接して設けられたセパレータを通して各電極に導入される。この場合、大量の燃料と酸化剤ガス等の反応物質をポンプやブロワに負荷を与えないように流すという観点から、セパレータまたは電極板のガス流路はできるだけ圧損が生じないようにある程度の深さを有する溝形状にしてある。特にメタノール等の液体燃料を用いた場合には、上述したリン酸型燃料電池とは異なり液体状の燃料を流すため、圧損に関しては、ガスを燃料とする場合よりさらに大きな値となる。

【0020】このように従来の構造の燃料電池では、この反応物質の流路としてセパレータなどに溝を形成する必要があるためある程度の厚さを要し、本来の発電部である電解質層と燃料および酸化剤極の反応触媒および集電体以外の占める体積を大きくせざるを得ない。仮に、流路として作用する電極板ないしセパレータを薄く小さくしたとしてもこの場合には狭い流路を通して反応物質を供給するためにポンプ、ブロワなどに負担がかかり、それらの機構を大きくせざるを得ない。

【0021】このようなことから、本来の発電部である電解質層と燃料極および酸化剤極の反応触媒および集電体以外の占める体積をできるだけ小さく抑え、燃料電池全体の小型化を図る方策として例えば複数の起電部を厚さ方向に垂直に、すなわち横並びに並べて、その端部で互いに直列になるように接続する方法が考えられる。この場合には複数の起電部に対し、1つの空間から反応物質の供給、生成物の回収が行え、またセパレータが不要になるばかりでなく、電極板にも流路としての機能を持たせる必要がないため省路ないし薄くすることができ、このような考え方はすでに特開昭63-141266号公報、特開昭63-141270号公報などに開示されている。

【0022】しかしながらこのような構成の燃料電池では以下に示されるような問題が生じる。

【0023】通常の燃料電池では電解質層からの電解質中の成分の流出・蒸発を捕い、あるいは乾燥を防止するために供給する反応物質に電解質層中に含有される物と同種の電解質や水蒸気が混入されている。

【0024】中でも、前述のナリオンロコカーボンスルホン酸（商品名：Narion Du Pont社製）などのプロトン導電性膜等を電解質として用いた固体高分子電解質型燃料電池は、稼働時に、燃料極から酸化剤極へ、イオンと共に水が流れるので、次第に燃料極側の水分が不足し、効率が低下する。したがって燃料極に供給する燃料中には、メタノール等の液体の場合は液体の電解質を、水素ガスの場合は、水蒸気を混入させて供給していた。

【0025】一方、他方の電極においては水の生成が起こる。前述の固体高分子型燃料電池においては、酸化剤極側は、電極極端により生成する水の他、燃料極から流れてくる水が存在するので水分が過剰になる。

【0026】このような反応物質に混入して供給した水や電解質、あるいは生成した水は、複数の発電素子間をイオンの結合・短絡させ、電池電圧の低下を引き起こす原因となる。特に、上記水や電解質が液体の状態で存在すると、その問題は顕著である。

【0027】前述の如く、複数の発電素子を横並びに並べ、その端部を直列に接続した構成の燃料電池は、燃料の供給空間、生成物の回収空間を共有し、かつ電極間の距離が短いためこのような電圧ロスの問題は一層深刻である。

【0028】図28に、2個の発電部を横並びに並べかつ直列に接続した場合の概略図を示す。図28において37は燃料極、60aは電解質層、38は酸化剤極であり、2つの起電部55はリード57によって電気的に直列に接続されている。二つの発電部の燃料極37a、37b及び酸化剤極同士は、隣り合っている。燃料の供給及び生成物の排出は、両発電部とも一つの空間から行うことができる。図28においては燃料の供給は燃料流路58から、酸化剤ガスの供給は酸化剤流路59にて行っている。

【0029】この場合、一つの発電部の燃料極37aと、この発電部の酸化剤極38aと同電位の燃料極37bとの間には、電位勾配が生じている。また酸化剤極38aと酸化剤極38bとの間にも同様に電位の勾配が生じている。

【0030】このとき両起電部表面つまり、燃料流路58、酸化剤流路39に電解質として作用する物質が存在していると前述の電位勾配にしたがってイオンの移動が起こり、これが漏れ電流として作用して電圧ロスが生じる。

【0031】したがって、上記の如く、複数の発電部を横並びにして直列に接続し、燃料供給空間、生成物の回収空間を共通とする構造によって、燃料電池の小型化を図る場合には、各発電部間に生じる電圧ロスにより電池の効率が低下してしまうため、このような電圧ロスを低減する必要がある。

【0032】一方、一般に燃料電池に供給する燃料としては、水素ガス等の気体かメタノール、ヒドラジン等の液体がある。燃料としてガスを使用する場合は、OA機器等の消費電力が小さいとはいえず、ガスの密度を考えると発電に要するガス量は大きく、電池の小型化には不向きである。これに対して液体燃料はガスに比べると、密度が高く、小型機器用の燃料電池の燃料としては、圧倒的に有利である。従って液体燃料を用いた燃料電池が小型化できれば、従来にない長時間動作が可能な小型装置の電源が実現できる。

【0033】液体燃料の中でも、メタノール、エタノールなどのC1～C2化合物は安価であり、沸点も適度が高いので、安全面から手軽に用いることができる。しかし、そのような電池における技術的難点として、電極触媒の開発がある。すなわち、メタノールのような炭素を含む燃料のアノード酸化においては、触媒活性の高い白金でも、時間の経過と共に反応の中間生成物が電極表面に強固に吸着する被毒現象が現れ、大幅な触媒能の低下をもたらすため、実用上重大な問題点となっている。

【0034】そのため耐被毒性に優れた電極触媒が検討されているが、いまだ十分な特性を得るには至っていない。そのため、長時間、安定して高出力が得られる燃料電池は今のところ得られていない。したがってメタノール等の有機燃料を用いた燃料電池の場合、電極表面の被毒現象を抑制する必要がある。

【0035】上述したように、一般的な従来型の燃料電池はシステムが複雑で、そのままの構成では小形化が困難であるという問題を有している。一方、毛管力を利用した従来の液体燃料電池は、構成上は小形化に適するものの、構造が複雑でかつ構造上の制約も多いために、例えば小形機器用の電源等に適するような小形化は達成されていない。また、電池部品の締め付け方法、生成した水の排出、および起電部間の接続等についても、燃料電池の小形化への対応が求められている。さらに液体燃料を用いた場合に電極表面の被毒についても対応が求められている。

【0036】

【発明が解決しようとする課題】本発明は上記の従来の燃料電池における上記課題を解決し、小形機器の電源として有用な小形燃料電池を提供するために行われたもので、本発明の目的の第1は、液体燃料および酸化剤ガスの供給システムを簡易化すると共に、構造を簡素化することによって、高効率を維持した上で小形化することを可能にした燃料電池を提供することにある。

【0037】目的の第2は、燃料電池の動作に伴って生成する水の排出を、特別な動力やエネルギーを用いることなく行い小形化に適した燃料電池を提供することにある。さらに、目的の第3は、起電部間のイオン伝導を最小限に抑え、燃料電池の小形化に適した起電部間の接続を行っても電圧ロスが少なく十分実用に適した燃料電池を提供することにある。さらに、目的の第4は、小形の燃料電池に用いる燃料として適したメタノール等の液体有機燃料を用いた場合に、電極表面に生じる被毒現象を抑え、長時間安定した出力が得られる燃料電池を提供することにある。

【0038】

【課題を解決するための手段および作用】本発明は上述の目的を達成するために行われたもので、目的の第1である原料供給システムの簡易化にする第1の燃料電池は、燃料極、酸化剤極およびこれら両電極に挟持された

電解質板を有する起電部を複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも1つの面に沿って、前記酸化剤ガスの流れと直交するような方向に、前記燃料極の端面に前記液体燃料が直接接する液体燃料導入路を設け、該液体燃料を毛管力で前記燃料極に供給するよう構成したことを特徴としている。

【0039】第2の燃料電池は、燃料極、酸化剤極および両電極に挟持された電解質板を有する起電部をセパレータを介して複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、前記セパレータの前記酸化剤極と接する面には、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設け、かつ、前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも1つの面に沿って、前記酸化剤ガスの流れと直交するような方向に、前記燃料極の端面に前記液体燃料が直接接する液体燃料導入路を設け、前記酸化剤ガスを前記酸化剤ガス供給溝を介して供給すると共に、前記液体燃料を前記燃料極となる多孔質体の毛管力で、該燃料極に供給するよう構成したことを特徴としている。

【0040】さらに、第3の燃料電池は、燃料極、酸化剤極および両電極に挟持された電解質板を有する起電部をセパレータを介して複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、前記セパレータの前記酸化剤極と接する面には、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設け、かつ、前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも1つの面に沿って、前記酸化剤ガスの流れと直交するような方向に液体燃料導入路を設けると共に、前記セパレータの前記燃料極と接する面には、前記液体燃料導入路に向けて一端が開口された液体燃料供給溝を設け、前記酸化剤ガスを前記酸化剤ガス供給溝を介して供給すると共に、前記液体燃料を少なくとも前記液体燃料供給溝の毛管力で、該燃料極に供給するよう構成したことを特徴としている。

【0041】またさらに、第4の燃料電池は、燃料極、酸化剤極およびこれら両電極に挟持された電解質板を有する起電部を複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、前記燃料極の前記酸化剤極と接する面には、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設

け、かつ、前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも1つの面に沿って、前記酸化剤ガスの流れと直交するような方向に、前記燃料極の端面に前記液体燃料が直接接する液体燃料導入路を設け、前記酸化剤ガスを前記酸化剤ガス供給溝を介して供給すると共に、前記液体燃料を前記燃料極となる多孔質体の毛管力で、該燃料極に供給するよう構成したことを特徴としている。

【0042】またさらに、第5の燃料電池は、燃料極、酸化剤極およびこれら両電極に挟持された電解質板を有する起電部を複数積層したスタックを具備し、燃料として液体燃料を用いると共に、酸化剤ガスを前記スタックの積層面に沿って垂直方向に流すよう構成した燃料電池において、前記酸化剤極に、前記酸化剤ガスを垂直方向に流す酸化剤ガス供給溝を設け、かつ、前記スタックの外周面のうち、前記燃料極の端面を含み、かつ前記酸化剤ガスの流れと平行に配置された少なくとも1つの面に沿って、前記酸化剤ガスの流れと直交するような方向に、前記燃料極の端面に前記液体燃料が直接接する液体燃料導入路を設け、前記酸化剤ガスを前記酸化剤ガス供給溝を介して供給すると共に、前記液体燃料を前記燃料極となる多孔質体の毛管力で、該燃料極に供給するよう構成したことを特徴としている。

【0043】またさらに、第6の燃料電池は、燃料極、酸化剤極およびこれら両電極に挟持された電解質板を有する起電部を複数積層したスタックを具備する燃料電池において、前記スタックは、その少なくとも積層方向がゴム弾性を示す材料で締め付けられていることを特徴としている。

【0044】本発明の以上の燃料電池においては、まず酸化剤ガスをスタックに対して垂直方向に流すよう構成しているため、酸化剤ガスを効果的に流すことができる。また、液体燃料導入路を、酸化剤ガスの流れと平行に配置されたスタック外周面に沿って、酸化剤ガスの流れと直交するような方向に設け、この液体燃料導入路内に導入された液体燃料を毛管力で燃料極に供給するよう構成しているため、酸化剤ガスの流れを阻害することなく、液体燃料の毛管力による確実な供給が可能となる。また、構造を簡素化することができると共に、構成上の制約も少ない。これらにより、ポンプやブロー等の補助部品を特に用いることなく、酸化剤ガスおよび液体燃料を円滑に供給することができ、よって小型化を図ることが可能となる。

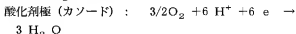
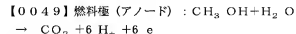
【0045】本願の第2の目的である生成水の排出方法の改善された燃料電池は、下記の構成を有するものである。

【0046】即ち、燃料極と、酸化剤極と及びこれらの両電極に挟持された電解質層を有する発電部と、酸化剤極に接して設けられ酸化剤極から生じる水を吸収する第

1の多孔体と、第1の多孔体に接して設けられ第1の多孔体が保持する水を吸収する第2の多孔体は水の流れる方向に沿って平均細孔径が小さくなるように構成されていることを特徴とする燃料電池である。

【0047】例えば、メタノール等の液体燃料を用いた燃料電池においては、以下に示す機構で燃料電池として作動する。

【0048】メタノール等の燃料は燃料極に供給され、酸化剤極には酸素が供給される。メタノールを例とした場合次のような反応が起こる。



全反応： $\text{CH}_3\text{OH} + \frac{3}{2}\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$
すなわち、燃料極ではメタノールが水と等モル反応し、炭酸ガスとプロトンを生じ、プロトンは固体高分子電解質膜を通して燃料極で酸素と反応して3モルの水を生成する。合計では、メタノールと酸素が反応して2モルの水を生成する。このような反応をスプースに行わせるには少なくとも生成する水をすみやかに除去する必要がある。

【0050】また、小形機器用の電源を想定した場合、特別な動力なしにこれを行う必要がある。

【0051】そのために本願発明における、酸化剤極の構造は多孔体を酸化剤極表面に接するよう設けるか、あるいは酸化剤極自体を多孔体とし、多孔体の毛細管現象の作用で酸化剤極に生じた水を吸収する。さらに水の回収は、酸化剤極表面に接するよう設けられた多孔体あるいは多孔体からなる酸化剤極自体よりも毛細管力の強い多孔体、すなわち平均細孔径が前記多孔体より小さい多孔体を酸化剤極表面に接するよう設けられた多孔体あるいは多孔体よりなる酸化剤極に接触させる。それにより水がスプースに酸化剤極表面より除去されるものである。

【0052】本発明は、特に酸化剤極で生成する水が液体である温度、すなわち約100℃以下の温度で作動する燃料電池に適用すると有効である。すなわち、多孔体の毛細管現象による水の吸収は、水が液体の場合に有効に作用するためである。

【0053】作動温度が約100℃以下の燃料電池としては、アルカリ型燃料電池、特殊な運転条件下におけるリン酸型燃料電池、固体高分子電解質型燃料電池などがある。特に固体高分子電解質型燃料電池に使用される固体高分子電解質はイオン交換能を有する高分子化合物からなり、これを膜状に形成したものは電解液の流失が無く、アノードとカソードの反応物質の混合を防止され、燃料電池系を小型化、単純化する上で適している。現状ではプロトン電導性の固体高分子膜が実用化しているが、アニオン電導膜を使用してもよい。

【0054】また、燃料電池の小型化を考慮した場合、

燃料としては水素ガス等の使用が可能である。例えば水素吸蔵合金に吸蔵された水素ガスを用いてもよい。しかし常温で液体であるメタノール、エタノールのようなアルコール類あるいはヒドラジンあるいはアミン酸のような燃料を使用することが実用上好ましい。

【0055】本願の目的の第3である起電部間の電圧ロスの少ない燃料電池は下記のような構成を有している。即ち、燃料極と酸化剤極およびこれらの電極に扶持された電解質層を有する起電部を備え、複数の起電部が直列に接続され、各起電部の燃料極が共通の燃料流路から燃料が供給され、かつ各起電部の燃料極の電極面が前記燃料流路に面しているか、または各起電部の酸化剤極が共通の酸化剤流路から酸化剤が供給され、かつ各起電部の酸化剤極の電極面が前記酸化剤流路に面している構造の燃料電池において、前記の電解質層が吸水性もしくは保水性物質を含有していることを特徴とするものである。

【0056】すなわち、以上の燃料電池においては、起電部の電解質層として通常の電解質の主要構成物質であるイオン交換能力を有する化合物の他に、膜内部に水分を供給・保持し、あるいは濃度勾配にしたがって水分を通過させることが可能な吸水性もしくは保水性物質を並存させたものが用いられる。

【0057】以上のように本発明に係る電解質層は自ら吸水性ないし保水性を示すために一方の電極触媒表面で生成した水を速やかに吸収して触媒表面を常に反応性物質と接触できる状態に保つと共に、吸収した水は電解質中を濃度勾配にしたがって拡散し、他方の電極表面の乾燥を防止する働きも示す。さらにこの過程において電解質自体も外部からの水分の添加無しに常に有効なイオン解離、イオン伝導特性を維持できるといった優れた性質を示す。

【0058】したがって、この電解質層を用いた燃料層では、供給する反応物質中には水を混入させずに電解質中に水を供給出来、また、酸化剤極において生じた水はすみやかに吸収されるため、電解質層以外でのイオン伝導を小さく抑えることができる。

【0059】本発明に係る吸水性もしくは保水性物質としては、澱粉、アクリロニトリル共重合体、架橋アクリル酸塩、架橋ポリエチレンオキサイド等の吸水性高分子化合物、シリカヒドロゲル、変成蛋白質（ゼラチン）等のゲル状化合物などが利用できる。

【0060】また、電解質としては、固体高分子電解質の場合に本願発明の顕著な効果が得られる。固体高分子電解質としては、プロトン導電性固体高分子電解質として、パーフルオロカーボンスルホン酸ポリマー（商品名：Nafion[®] 米国Du Pont 社製）スルホン酸基を有するポリスチレン系の陽イオン交換膜が挙げられる。

【0061】このような起電部を用いることにより、本発明の骨子である酸化剤極および燃料極に供給する反応物質のいずれの中にも電解質として作用する物質を不可

避混入粒以上は含まず、かつ複数の起電部の端部を互いに直列に接続した構成である燃料電池を実現することができる。

【0062】次に、複数の発電素子の端部を互いに直列に接続する方法としては各発電素子の集電体を溶接・導電性接着剤などにより直接接続する方法、反応物質の混合・漏れ電流を防止するために導電板などを介して接続する方法、あるいは発電部を製作する際に複数の発電部を予め直列接続されるように一体化させて製作する方法などが採用できる。

【0063】さらに、これらの方法において電解質の漏れを抑えるために複数の起電部の接続部分を覆水処理することも有効である。

【0064】次に本願の目的の第4である電極表面に生じる被毒現象を抑えるための燃料電池は、燃料極と酸化剤極及びこれら両電極に扶持された電解質層を備えた燃料電池において、燃料極をアノードに分離させる機構を備えたことを特徴とするものである。

【0065】即ち、本発明においては、燃料電池の運転時に燃料極表面の被毒生成物が生じた場合に、燃料極に対極を接続しアノードに分離させ、前記被毒生成物を酸化除去するものである。それにより、長時間安定した出力の得られる燃料電池が得られる。

【0066】さらに通常燃料電池においては、燃料極、酸化剤極および電解質からなる起電部を複数個直列に接続して用いている。この場合には、前記分組操作を各起電部ごとにローテーションとして行うことが好ましい。これにより運転を中断することなく、被毒生成物の除去を行うことができる。

【0067】

【実施例】以下、本発明の実施態様について説明する。まず、本願の目的の第1である、液体燃料および酸化剤ガスの供給システムの簡素化、ならびに構造の簡素化により、高効率維持した上で小型化された燃料電池について説明する。

【0068】図1は、一実施例の燃料電池の要部構成を示す一部切り欠き斜視図である。図において、1は燃料極（アノード）2と酸化剤極（カソード）3とにより扶持された電解質板であり、これら電解質板1、燃料極2および酸化剤極3によって起電部4が構成されている。ここで、燃料極2および酸化剤極3は、燃料や酸化剤ガスを流通させると共に電子を通すように、導電性の多孔質体で形成されている。

【0069】そして、上記したような起電部4をセパレータ5を介して複数積層することにより、電池本体となるスタック6が構成されている。このスタック6は、基本的には起電部4の積層面が垂直方向に対して平行となるように設置される。なお、上記セパレータ5は、発生した電子を伝導する集電板の機能も果たすため、導電性材料により形成される。さらに必要に応じて、燃料極2

や酸化剤極3と電解質板1との間に、層状、島状、あるいは粒状等の触媒層を形成することもあるが、本発明はこのような触媒層の有無に制約を受けないものではない。また、燃料極2や酸化剤極3自体を触媒電極としてもよい。

【0070】ここで、本発明の燃料電池において、動力を必要とせずに酸化剤ガス例えば空気を効果的に流すためには、酸化剤ガスがスタック6に対して垂直方向に流れるような構造とする必要がある。特に、スタック6の下部から上部に向かって酸化剤ガスを流すことにより、電池反応を生じた結果発生する熱で、酸化剤ガスは極めて円滑に流れることになる。そこで、この実施例では、セパレータ5の酸化剤極3と接する面に、酸化剤ガスを垂直方向（図中、z方向）に流す酸化剤ガス供給溝7を連続溝として設けている。

【0071】また、ガスの密度は液体に比べると著しく小さいため、電池反応に必要な供給燃料と酸化剤ガスのバランスを考えると、液体燃料の供給より酸化剤ガスの供給を増す構造にするのが効率的。性価、ひいては電池の小形化のために有利である。この観点からは、酸化剤ガス供給溝7の断面積を大きくするほど有利になるが、溝断面積を大きくするために溝幅を大きくし過ぎると、電気的な接触面積が小さくなってロスが生じ、また深さを深くし過ぎると、電極厚さもしくはセパレータ5の厚さが厚くなって小型化には不利となる。また、溝の断面積を小さくして溝数を多くすると、ガス供給溝7内での酸化剤ガスの圧力損失が大きくなり、酸化剤ガスを円滑に流すことが困難となる。従って、溝7の幅としては0.5～2.0mm程度が、また溝7の深さとしては0.2～2mm程度が好ましい。なお、これら酸化剤ガス供給溝7の形状は、後述する燃料ガスの供給方法等を考慮して決定するものとする。

【0072】上述したように、この実施例におけるセパレータ5は、酸化剤ガスを流すチャンネルとける機能を併せ持つものである。このように、セパレータとチャンネルの両方の機能を有する部品5（以下、チャンネル兼用セパレータと記す）を用いることにより、より部品点数を削減することができ、小形化をより一層図ることが可能となる。なお、上記セパレータ5に代えて通常のチャンネルを用いることも可能である。

【0073】上記したようなチャンネル兼用セパレータ5は、孔のない金属板で形成してもよいし、また多孔質体であってもよく、液体燃料と酸化剤ガスを分離し得るものであればよい。なお、多孔質体を用いる場合には、液体燃料が酸化剤極3に侵入しないように、チャンネル兼用セパレータ5の燃料極側の面および酸化剤極側の面の少なくとも一方の孔を塞ぐことが好ましい。さらに、酸化剤ガスの流れをよくするために、多孔質体からなるチャンネル兼用セパレータ5の孔径は、酸化剤極3となる多孔質体の孔径より大きく設定することが好まし

い。

【0074】さらに、酸化剤ガス供給溝7の形は、上述したような条件を満足するものであれば特に制約を受けるものではなく、例えば図2に示すように、金属薄板をプレスや圧延等で折り曲げ加工したチャンネル兼用セパレータ8を用いることも可能である。このようなセパレータ8は、酸化剤極3側に酸化剤ガス供給溝7が設けられると共に、燃料極2側にも連続溝9を設けることができる。また、チャンネル兼用セパレータ5（8）に酸化剤ガス供給溝7を設けると共に、酸化剤極3にも酸化剤ガスを垂直方向に流す溝を設けることも可能である。

【0075】上記したスタック6の少なくとも1つの側面には、この面に沿って液体燃料導入路10が形成されるように、燃料導入路構成部材11が設置されている。そして、上記液体燃料導入路10内に導入された液体燃料（通常、電解質である例えば希硫酸と燃料となるメタノールとの混合液）は、スタック6の側面から毛管力で燃料極2に供給される。ここで、酸化剤ガスを下部から上部に向かって流す際に、液体燃料導入路10をスタック6の上部もしくは下部に設けると、スタック6の構造が極めて複雑となる。よって、液体燃料導入路10は、スタック6の外周面のうち、上下面を除いた4つの面のいずれかに沿って設けると共に、酸化剤ガスの流れと直交するような方向（図中、x方向）に設けることが重要である。また、液体燃料導入路10中の液体燃料を毛管力でスタック6の側面から燃料極2に供給するためには、上記した4つのスタック側面のうち、起電部4の端面で構成される2つの側面の少なくとも一方（例えば側面4a）に沿って、液体燃料導入路10を設ける。すなわち、上記液体燃料導入路10は、スタック6の外周面のうち、起電部4の端面で構成される面、換言すると燃料極2の端面を含む面で、かつ酸化剤ガスの流れと平行に配置された少なくとも1つの面4aに沿って、酸化剤ガスの流れと直交するような方向に設けられている。また、毛管力で液体燃料を燃料極2に供給するために、液体燃料導入路10内に導入された液体燃料が、上記起電部端面4aに直接接触するような構成とされている。

【0076】これらによって、酸化剤ガスの流れを阻害することなく、燃料極2の端面全面を液体燃料と接する構造とすることができ、液体燃料導入路10中の液体燃料を毛管力で円滑に燃料極2に供給することが可能となる。そして、この実施例の燃料電池は、酸化剤ガスの供給方向（z方向）と液体燃料のスタック6端面への導入方向とを基本的には直交させているために、構造を簡素化することができると共に、構造上の制約が少なく、よって小形化することが可能となる。

【0077】なお、上記燃料導入路構成部材11は、スタック6の締め付け部材と共通してもよいし、また別途設けることも可能である等、その構成や材料に特に限定されるものではない。ただし、燃料導入路構成部材1

1のスタック6側面と接する部分は、電池間の短絡を防ぐために、絶縁されていなければならない。これは、例えば燃料導入路構成部材11自体を絶縁材料で構成したり、あるいは燃料導入路構成部材11とスタック6との間に絶縁材料を介在させることにより行う。

【0078】上述した液体燃料導入路10の形状は、基本的には図示を省略した燃料貯蔵タンクから液体燃料が導入され、この導入された液体燃料が燃料極2に毛管力で供給されるものであればよい。燃料貯蔵タンクから液体燃料導入路10に液体燃料を供給する方法の一つに、燃料貯蔵タンクの液体燃料を自然落下させて、液体燃料導入路10に導入する方法がある。この方法は、スタック6の上面より高い位置に燃料貯蔵タンクを設けなければならないという構造上の制約を除けば、液体燃料導入路10に確実に液体燃料を導入することができる。他の方法としては、液体燃料導入路10の毛管力で、燃料貯蔵タンクから液体燃料を引き込む方法が挙げられる。この方法によれば、燃料貯蔵タンクと液体燃料導入路10との接続点、つまり液体燃料導入路10に設けられた燃料入口の位置を、スタック6の上面より高くする必要がなくなり、例えば上記自然落下法と組み合わせると、燃料タンクの設置場所を自在に設定することができるという利点がある。

【0079】液体燃料導入路10に毛管力を付与するには、液体燃料の種類や燃料導入路構成部材11の材質によって異なるものの、液体燃料導入路10の隙間（図中、 t で示す）を0.2～5mm程度とすることが好ましい。液体燃料導入路10の隙間 t が0.2mm未満となると、液体燃料の供給不足を生じおそれがあり、また5mmを超えると、十分な毛管力が得られないおそれが生じる。さらに、電池の作動を長期止めた際に、液体燃料導入路10内の液体燃料は揮散して無駄になることや、揮散に伴う臭気等を考慮すると、液体燃料導入路10の体積は小さい方が有利である。また、毛管力を向上させることも考慮して、液体燃料導入路10の隙間 t は3mm以下とすることがより好ましい。

【0080】ただし、毛管力で液体燃料導入路10に導入された液体燃料を、引き続き円滑に毛管力で燃料極2に供給するためには、液体燃料導入路10の毛管力より燃料極2への毛管力のほうが大きくなるように設定することが重要である。さらに、液体燃料導入路10の毛管力を向上させるために、その内部に絶縁性の多孔質体や繊維を配置してもよい。この場合、上記液体燃料導入路10の隙間 t は5mmを超えてもよい。なお、液体燃料導入路10の数は、スタック6の側面に沿って1つに限定されるものではなく、他方のスタック側面にも液体燃料導入路10を形成することも可能である。

【0081】また、上述したような燃料貯蔵タンクは、電池本体から着脱可能とすることができる。これにより、燃料貯蔵タンクを交換することで、電池の作動を維

続して長時間行うことが可能となる。この場合、電池交換時にも装置を継続して作動させるために、燃料貯蔵タンクを切り離した際に、電池内に燃料が残っている必要がある。このような燃料貯蔵部は、液体燃料導入路10と燃料極2への供給部、あるいは燃料極2自体であり、燃料貯蔵タンクの交換時間と考えると、残存する燃料の量は少なくとも1分以上は装置を作動できる量とすることが望ましい。また、燃料貯蔵タンクから液体燃料導入路10への液体燃料の供給は、上述したような自然落下や、タンク内の内圧等で液体燃料を押し出すような構成としてもよいし、また液体燃料導入路10の毛管力で燃料を引き出すような構成とすることもできる。この場合、自然落下やタンク内の内圧による場合には、燃料貯蔵タンクの出口隙間は液体燃料導入路10の隙間に制約されないが、毛管力による場合は液体燃料導入路10の隙間より燃料貯蔵タンクの出口隙間を大きくすることが望ましい。

【0082】上述したような方法によって、液体燃料導入路10内に導入された液体燃料は、毛管力により燃料極2に供給される。この液体燃料を燃料極2側に引き込むための毛管力としては、まず燃料極2となる多孔質体自体の毛管力が挙げられる。このような毛管力を利用する場合、多孔質体である燃料極2の孔を連結させた、いわゆる連続孔とし、その孔径を制御すると共に、液体燃料導入路10側の燃料極2側面から少なくとも他の一面まで連続した連通孔とすることにより、液体燃料を横方向でも円滑に毛管力で供給することが可能となる。また、電池面積が大きくなると、液体燃料の供給速度が遅くなるばかりでなく、液体燃料の入り口側で集中的に電池反応が進行するため、液体燃料導入路10から遠くなるほど燃料の供給量が減少するおそれがある。このような場合には、前述した条件を満足する他方のスタック面にも液体燃料導入路10を設けることが有効である。

【0083】燃料極2となる多孔質体の孔径等は、液体燃料導入路10内の液体燃料を引き込み得るものであればよく、特に限定されるものではないが、液体燃料導入路10の隙間を考慮した上で、2～300 μm 程度とすることが好ましい。また、多孔質体における孔の連続性の指標となる孔の体積は、35～80%程度とすることが好ましい。孔径を0.2 μm より小さくすると、燃料極2の製造が困難となり、また300 μm を超えると毛管力が低下してしまう。また、孔の体積が35%未満となると連続孔の量が減り、閉鎖された孔が増えるため、毛管力を十分に得ることができなくなる。逆に、孔の体積が80%を超えると、連続孔の量は増加するものの、強度的に弱くなると共に製造が困難となる。実用的には、孔径は0.5～100 μm の範囲、また孔の体積は45～75%の範囲とすることが望ましい。

【0084】また、液体燃料を毛管力で燃料極2内に引き込むためには、燃料極2中の空気が引き込まれた液体

燃料で追い出されるように、液体燃料導入路10側の側面以外の側面の少なくとも一つを開放することが好ましい。ただし、燃料極2の上記した面以外の側面は、液体燃料の揮発を抑制する上で塞ぐことが好ましい。

【0085】液体燃料を燃料極2側に引き込むための毛管力としては、上述した燃料極2となる多孔質体自体の毛管力に限らず、例えば図3に示すように、チャンネル兼用セパレータ5の燃料極2と接する面に、液体燃料供給溝12を連続溝として水平方向（図中、y方向）に設け、この液体燃料供給溝12の毛管力を利用して液体燃料を燃料極2側に引き込むよう構成することも可能である。この場合、液体燃料導入路10は、少なくとも液体燃料供給溝12の開放端部と液体燃料が直接接するように設けるものとする。また、液体燃料供給溝12の毛管力と燃料極2となる多孔質体自体の毛管力とを併用することも可能である。

【0086】上記液体燃料供給溝12の形状は、毛管力が発揮できれば特に制約を受けるものではないが、少なくとも溝12による毛管力を燃料極2の毛管力より小さく必要がある。もし溝12の毛管力が燃料極2のそれより大きいと、液体燃料導入路10中の液体燃料は、液体燃料供給溝12内には供給されるものの、燃料極2には供給することができなくなる。液体燃料供給溝12の形状は、チャンネル兼用セパレータ5の構成材料と液体燃料との濡れ性によって異なるものの、その幅は0.2～10mmの範囲とすることが好ましい。

【0087】液体燃料供給溝12の幅が10mmを超えると、毛管力が小さくなり、結局燃料極2の毛管力が主体となって、液体燃料供給溝12を形成した意味がなくなる。逆に、溝12の幅が0.2mm未満となると、毛管力は向上するものの、液体燃料の供給が電池反応に追い付かなくなる上に、通常の製法では溝を切るのが難しく、特殊な製法が必要になる。溝の深さについても同様で、溝の深さとしては0.1～2mmの範囲とすることが好ましい。特に、溝12の深さを深くしすぎると、チャンネル兼用セパレータ5の肉厚を厚くさせるを得ず、その結果小型化を阻害することとなる。さらに、燃料の供給を止めて発電を中止した際に、多量の液体燃料が残存していると、揮散して無駄になるばかりでなく、揮散に伴って臭気を発するおそれがあるため、溝の深さは1mm以下とすることが好ましい。また溝の幅は、同様な理由に加えて電気的な接触を多くするため、5mm以下とすることがより好しく、望ましくは3mm以下である。

【0088】また、上記液体燃料供給溝12は、液体燃料導入路10からその毛管力で液体燃料を引き込むものであるため、前述したように、燃料貯蔵タンクから液体燃料導入路10にその毛管力で液体燃料を導入する場合に、液体燃料導入路10の毛管力より液体燃料供給溝12の毛管力のほうが大きくなるように設定する。このように毛管力の差は、基本的には液体燃料導入路10と

液体燃料供給溝12の断面積、およびセパレータ5の構成材料と燃料導入路構成部材11の材料で決まるものであるが、望ましくは液体燃料導入路10の隙間より液体燃料供給溝12の幅および深さの少なくとも一方を小さくすることが好ましい。このように、液体燃料供給溝12の形状は、燃料極2となる多孔質体や液体燃料導入路10の形状を考慮した上で設定するものとする。また、液体燃料供給溝12の形状は、酸化剤ガス供給溝7の形状をも考慮する必要があり、例えば酸化剤ガス供給溝7の幅および深さが液体燃料供給溝12のそれより1.1～2.0倍程度となるように設定することが好ましい。さらに望ましくは1.2～1.0倍程度である。

【0089】上記液体燃料供給溝12は、必ずしも水平に設けなければならないものではなく、垂直方向（z方向）に向かって45度～90度の範囲で傾けて形成してもよい。ただし、傾きが大きくなると、液体燃料供給溝12の形成領域が狭くなり、それだけ有効な供給路は減少することになるため、傾きとしては30度以下にすることが望ましい。なお、液体燃料導入路10をスタック6の両面に設ける場合はこの限りでない。

【0090】このように、チャンネル兼用セパレータ5に例えば水平方向に延びる液体燃料供給溝12を設けることによって、燃料極2の端部全面から液体燃料が燃料極2に供給されると共に、溝12を通して燃料極2の横方向にも同時に燃料を供給できるため、液体燃料導入路10内の液体燃料を、より一層層間に燃料極2に供給することが可能となる。これにより、起電部4全面で均一に電池反応を進行させることが可能となり、高効率を達成することができる。なお、上記した実施例では、チャンネル兼用セパレータ5に酸化剤ガス供給溝7と液体燃料供給溝12の両方を形成したもののについて説明したが、燃料極2および酸化剤極3に対して個々にチャンネルを設置してもよい。このような場合には、両チャンネル間にガスを透過させない導電性板を設置したり、少なくとも一方のチャンネルの面の孔を塞ぐ等によって、液体燃料と酸化剤ガスとの分離を図るようになる。ただし、部品点数の削減、ひいてはより一層の小形化が可能とするためには、チャンネルを兼用することが好ましい。

【0091】また、液体燃料導入路10から燃料極2に毛管力で液体燃料を引き込むにあたって、毛管力の向上は重要である。毛管力は、前述したように毛管通路の隙間が小さく、かつ毛管通路の液体燃料に対する濡れ性が大きくほど大くなる。毛管通路の液体燃料に対する濡れ性を大きくする観点からは、毛管力を起こす毛管部表面の改良が有効で、特に該表面に酸化被膜を設けることが有効である。すなわち、燃料極2の多孔質体内表面やチャンネル兼用セパレータ5に設けた液体燃料供給溝12の内面に酸化被膜を設けることによって、毛管力は著しく大きくなり、液体燃料を電池内に引き込む速度が速

くなるばかりでなく、液体燃料の到達距離を延ばすことができる。これにより、燃料電池の面積が大きくても対応できるようにするばかりでなく、電池を立ち上げる際の所要時間を短くすることができる。ただし、上記酸化被膜は、多孔質体の空孔率を低下させないように形成することが好ましい。特に、液体燃料導入路10と接する燃料極2の端面では、酸化被膜の形成により液体燃料の入口を塞がないようにすることが重要である。

【0092】ところで、燃料極2は、電池反応の結果発生した電子を伝導しなければならない。従って、燃料極2表面に設けられる酸化被膜は、上記電子伝導を阻害してはならない。燃料極2に設ける酸化被膜が絶縁性であるならば、燃料極2のセパレータ5やチャンネル等と接触する面の表面を除いて酸化被膜を形成する。また、液体燃料供給溝12内に酸化被膜を設ける場合においても、その内表面に限定して酸化被膜を形成する。

【0093】また、液体燃料導入路10への液体燃料の導入を毛管力で行う場合には、液体燃料導入路10の内表面についても酸化被膜の形成が有効である。

【0094】このような酸化被膜の形成方法としては、酸化雰囲気中や水蒸気雰囲気中で温度を上げて金属の表面を酸化させる方法や、アルカリ等の薬品で処理する方法等が挙げられる。また、酸化被膜の除去は、その部分を機械的方法、例えば研磨や切削等により行うことができる。

【0095】上記した各実施例においては、チャンネル兼用セパレータ5を介して起電部4を積層したスタック6を有する燃料電池について説明したが、本発明の燃料電池においてセパレータやチャンネルは必ずしも必要なものではない。例えば、図4に示すように、電解質板1を燃料極2と酸化剤極3とで挟持した起電部4を、直接複数積層してスタック13を構成することも可能である。この際、酸化剤ガス供給溝7は、例えば図4に示したように、燃料極2の酸化剤極3と接する面に垂直方向に連続溝として形成したり、また図5に示すように、酸化剤極3の燃料極2と接する面に垂直方向に形成する。また、図6に示すように、酸化剤極3の電解質板1と接する面に酸化剤ガス供給溝7を設けてもよい。さらに、酸化剤ガス供給溝7は電解質板1や燃料極2に接しなくてもよい。このように、燃料極2や酸化剤極3に直接、酸化剤ガス供給溝7を形成することによっても、酸化剤ガスを円滑に流すことができる。なお、これら以外の構成、すなわち液体燃料導入路10等は、前述した実施例の燃料電池と同様な構成とされている。そして、上記構成とすることにより、部品点数をより削減することができるため、より一層小型化を図ることができる。

【0096】また、上記したように燃料極2と酸化剤極3とが直接接するような構成とする場合には、燃料極2から酸化剤極3に液体燃料が引き込まれることを防止す

る必要がある。酸化剤極3に液体燃料が引き込まれると、酸化剤ガスが流れにくくなり、電池反応を阻害することになるためである。上記した酸化剤極3への液体燃料の侵入を防止する方法としては、基本的には酸化剤極3となる多孔質体の孔径を、液体燃料を毛管現象で引き込まないような大きさに制御すればよい。ただし、適用する機器によっては、上記孔径を毛管現象で液体燃料を引き込むような大きさにしなければならない場合がある。そのような場合には、酸化剤ガス供給溝7が燃料極2または酸化剤極3のいずれに形成されているかにかかわらず、燃料極2となる多孔質体の酸化剤極3側の面の孔を塞げばよい。ただし、酸化剤極3に酸化剤ガス供給溝7を設ける場合、酸化剤極3の溝7を除く燃料極2側の面の孔を塞いでもよいが、液体燃料が酸化剤ガス供給溝7の側面を通して酸化剤極3に侵入するおそれがあり、この場合は酸化剤極3の燃料極2との接触面および酸化剤ガス供給溝7の側面の孔を塞ぐことが好ましい。

【0097】上記孔を塞ぐ方法としては、燃料極2と酸化剤極3との導通を阻害しない材料をスラリー状にして塗布したり、当該面に研磨や研削等の加工を施し、その際に多孔質体にする塑性変形で孔を塞ぐ方法や、さらには電子ビームやレーザーにより当該面を溶融、凝固させる方法等が挙げられる。また、酸化剤ガス供給溝7を酸化剤極3に形成する場合には、燃料極2と酸化剤極3との界面に、液体燃料を通さない例えば金属板等の導電性材料を挟むことによっても、酸化剤極3に液体燃料が侵入することを防止することができる。

【0098】ところで、上記した各実施例の燃料電池は、いずれも液体燃料導入路10中の液体燃料が多孔質体である酸化剤極3の端部や電解質板1の端部に直接接する構造となっている。特に、酸化剤極3は、多孔質体でなければガスを電解質板1に供給できないため、その端部で液体燃料と接する場合には、液体燃料が酸化剤極3に毛管力で引き込まれ、引き込まれた液体燃料は酸化剤ガスの通路を閉塞させることとなる。従って、液体燃料が酸化剤極3の端部から入り込むのを防ぐ必要がある。

【0099】酸化剤極3への液体燃料の侵入の防止は、基本的には酸化剤極3となる多孔質体の孔径を、液体燃料を毛管力で引き込まないような大きさに制御すればよい。ただし、適用する機器によっては、上記孔径を毛管力で液体燃料を引き込むような大きさにしなければならない場合がある。このような場合の液体燃料の侵入防止は、例えば酸化剤極3の液体燃料導入路10側の面の孔を塞いだり、あるいは酸化剤極3の液体燃料導入路10と接する面をシール部材で覆う等の方法により行う。これらの具体的方法としては、例えば金属、無機物、セラミックス、有機物等の板、箔、膜等で側面を被覆したり、これらの単独もしくは複合粉末等をスラリー状に塗布する方法等が例示される。また、前述した塑性変形を

利用する方法や溶融、凝固させる方法を適用することも可能である。

【0100】また、後者の酸化剤極3の側面をシール部材で覆う方法としては、セパレータ5やチャンネル等を用いる場合には、例えば図7に示すように、酸化剤極3および電解質板1の側面に位置するように、燃料極2とチャンネル兼用セパレータ5とでシール部材14を挟む方法が挙げられる。この場合、シール部材14が電子伝導性を持っていると、燃料極2間の短絡が起って出力が得られなくなるため、シール部材14は絶縁性材料で形成する。なお、シール部材14は、必ずしも燃料極2とチャンネル兼用セパレータ5との間に挟まなければならないものではなく、例えば燃料極2間に挟んだり、あるいは酸化剤極3の側面のみ挟むこともできる。

【0101】また、セパレータやチャンネル等を用いない場合には、例えば図8に示すように、燃料極2間に同様なシール部材14を挟むことにより、酸化剤極3の側面をシール部材で覆うことができる。この際、シール部材14を酸化剤極3の側面に挟むこともできる。

【0102】ところで、起電部4を積層したスタック6（13）では、起電部4間の電気的な接触を確保するため、スタック6（13）を締め付けなければならない。この場合、上記シール部材14をゴム弾性を有する材料で構成することにより、換言すれば起電部4を締め付けた際に、起電部4部品やチャンネル兼用セパレータ5

（以下、スタック構成部品と記す）間に挟んだシール部材14がゴム弾性的に変形することにより、上記した電気的な接触を確実に得ることができると共に、液体燃料のシール効果を得ることができる。

【0103】すなわち、スタック構成部品間に挟む材料が変形しない剛体材料の場合、この剛体材料の厚さがそれにより覆われるスタック構成部品の厚さより薄ければ、スタック構成部品と剛体材料との間に隙間ができるため、液体燃料のシールはできない。逆に、剛体材料の厚さがそれにより覆われるスタック構成部品の厚さより厚ければ、スタック6（13）を締め付けると、酸化剤極3や電解質板1等の間に隙間ができ、電気的な接触が確保できなくなる。原理的には、上記した厚さが同じであれば、電気的な接触と液体燃料のシールの両立は可能であるが、実際には起電部4部品の厚さを厳密に一定にすることは困難である。

【0104】これに対して、スタック構成部品間に挟むシール部材14にゴム弾性を付与することにより、スタック6（13）を締め付けた際にシール部材14の変形で、スタック構成部品の厚さとシール部材14の厚さの差を吸収させることができる。これにより、電気的な接触と液体燃料のシール性を確実に得ることが可能となる。ゴム弾性材料としては、例えば生ゴムやデフロン製のゴム等、ゴム弾性を発現するものであれば種々の材料を使用することができる。

【0105】また、上述したようにスタック構成部品間にシール部材14を挟む場合、酸化剤極3への液体燃料の侵入をさらに確実に防止するためには、図9に示すように、酸化剤極3とシール部材14との間に隙間15を形成し、シール部材14と酸化剤極3とが直接接しないような構成とすることが効果的である。これにより、万一シールの不具合部から液体燃料が洩れた際にも、液体燃料が直接酸化剤極3に引き込まれるのを避けることができる。さらに、液体燃料の酸化剤極3への混入防止を確実にするには、酸化剤極3の側面の孔を塞ぐことである。

【0106】なお、酸化剤極3の液体燃料導入路10と反対側の側面は、ゴム弾性を有するシール部材を必ずしも設ける必要はなく、絶縁性の電池収納部材の一部をシール材として兼用してもよい。この場合、酸化剤極3への液体燃料の侵入を防ぐ観点から、少なくとも酸化剤極3の端部と電池収納部材との間に隙間を設けることが好ましい。

【0107】ところで、図1ないし図9においては、燃料極2、電解質板1および酸化剤極3が平面で接している場合を示したが、電池面積を大きくするために、それぞれの接触面を曲線状としてもよい。図10には、燃料極2と電解質板1との接触面が波状である場合を示す。波状面は、燃料極2と電解質板1との接触面、もしくは酸化剤極3と電解質板1との接触面の少なくとも一方に形成されていれよいが、電池反応の観点からは燃料極2と電解質板1との接触面が波形をしていることがより好ましい。

【0108】また、本発明の燃料電池においては、さらに燃料極の電解質板と接する面に、垂直方向の溝を設けることにより、燃料極での液体燃料の分解反応により生じた二酸化炭素を効率よく排出させることができる。

【0109】本発明の燃料電池においては、前述したように、スタック6（13）は起電部4間の電気的な接触を確保するために締め付けなければならない。この締め付けには、従来の燃料電池と同様な方法を適用することも可能であるが、図11に示すようにスタック16を、絶縁性を示しかつゴム弾性を有する材料で形成した電池締め付け部材17で締め付けるような構成とすることも可能である。このような電池締め付け部材17を用いることにより、スタック16の締め付けを容易にかつ確実に行うことが可能となる。

【0110】上記したように電池締め付け部材17を用いる際、その内寸法はスタック16を締め付けるために、スタック16の外寸法より小さくする。そして、電池締め付け部材17を広げ、その中にスタック16を挿入した後、電池締め付け部材17を広げている力を解放し、ゴム弾性材料の復元力でスタック16を締め付ける。この場合、液体燃料導入路10は、図11に示すように、電池締め付け部材17に設けてもよいし、電池締

め付け部材17とは別部品として形成することも可能である。

【0111】ところで、上記したゴム弾性を示す材料で形成した電池締め付け部材17は、前述の各実施例で示したメタノール燃料電池に限らず、各種の燃料電池に使用することができる。ただし、ゴム弾性材料の耐熱温度が燃料電池の運転温度以上であることが適用条件となる。このようなことから、一般的な耐熱性ゴム材料を使用する場合には、上述したメタノール燃料電池をはじめとして、例えばリン酸型燃料電池、固体高分子電解質型燃料電池、アルカリ性電解液型燃料電池、ヒドラジン燃料電池等に適用することが可能である。また、ゴム弾性を示す材料としては各種のゴムに限らず、金属製スプリング等を用いることも可能である。このような場合には、溶融炭酸塩型燃料電池や固体電解質型燃料電池等にも適用することができる。

【0112】上述したゴム弾性を示す材料で形成した電池締め付け部材を、一般的な燃料電池に適用する場合には、例えば図12に示すように、燃料槽、酸化剤極およびこれら両電極に挟持された電解質板、さらに必要に応じてガスチャネルを有する起電部（セル）を、必要に応じてセパレータを介して複数積層したスタック18の周囲を、上述した実施例と同様に、ゴム弾性を示す材料で形成した電池締め付け部材19で締め付ける。

【0113】図12では、スタック18の4周囲から電池締め付け部材19で均一に締め付けた例を示したが、締め付け力は少なくともスタック18の積層方向に加わるような構成であればよい。すなわち、スタック18を締め付ける本来の目的は、各電池部品間の接触をよくし、部品間の接触抵抗に起因する電気抵抗を極力小さくすることにあるため、その締め付け力は少なくともスタック18の積層方向に加わっていればよい。そこで、図13に示すように、スタック18の積層方向にゴム弾性部品20aを設けた電池締め付け部品20等を用いることも可能である。

【0114】図12に示したように、スタック18の外周面全てをゴム弾性材料で覆う場合には、電池締め付け部品19は断熱材としても機能する。また、図13に示したように、スタック18の側面の一部を開放するような電池締め付け部品20の場合には、その開放部20bから電池反応で生じた熱を外部に逃がすことができる。これらは、燃料電池の使用形態に応じて選択することができ、例えば初期の稼働性の向上を図る場合や、燃料電池からの放熱が周囲の部品等に対して悪影響を及ぼすような場合には、図12に示したような電池締め付け部品19が好適である。また、過度の蓄熱が燃料電池に悪影響を及ぼすような場合には、図13に示したような電池締め付け部品20が好適である。なお、図12に示したような電池締め付け部品19を用いる場合には、別途燃料電池の冷却機構を設けて使用することもできる。

【0115】また、図12や図13に示した電池締め付け部品19、20を用いる場合には、スタック18の面方向の締め付け力が大きすぎると、スタック18の角部に過度の力が加わり、角部が損傷を受ける可能性がある。このため、基本的にはスタック18の面方向への力で、角部が損傷しない範囲に締め付け力を調整する必要があるが、スタック18の角部を剛性材料で覆った後、電池締め付け部品19、20で締め付けることが好ましい。特に、図14に示すように、スタック18より大面積の剛性部材21を、スタック18の積層方向の両端面に設置し、その上からゴム弾性材料からなる電池締め付け部品19（20）で締め付けることによって、スタック18の各角部18aにかかる力をほとんど無視できる程度にまで低減することができる。なお、剛性材料がセル間を短絡させるような構造の場合、例えば剛性材料がスタック18の角部を囲むように折り込んだ構造の場合には、スタック18との間で絶縁を図る必要がある。ただし、剛性材料を電気の取り出し板と兼用する場合には、導電性の1枚板であることが好ましい。

【0116】電池締め付け部品の構造としては、図12や図13に示したものに限らず、上述したように、少なくともスタックの積層方向をゴム弾性で締め付けられる構造であればよく、例えば図15や図16に示すように、ゴム弾性材料と剛性材料とを組み合わせて電池締め付け部品を構成することも可能である。

【0117】図15は、スタック18の積層方向の両端面にそれぞれ剛性部材22を配置し、これら剛性部材22間を、スタック18の側面を覆うようなゴム弾性部品23で接続すると共に、スタック18を積層方向に締め付けた構造を示している。また、図16は、スタック18の積層方向の両端面にそれぞれ剛性部材22を配置し、これら剛性部材22を含めた周囲を帯状のゴム弾性部品24で締め付けた構造を示している。このように、ゴム弾性材料と剛性材料との組み合わせは、少なくともスタックの積層方向がゴム弾性で締め付けられていればよく、各種の組み合わせを使用することができる。

【0118】上述したような各種の電池締め付け部品は、スタック18が外部マニホールド方式であればマニホールドの上から締め付けてもよい。この場合、図11に示したように、電池締め付け部品の一部をマニホールドと兼用することもできる。

【0119】また、上述した各種の電池締め付け部品は、スタックを締め付けるために、少なくともスタックの積層方向に対応する内寸法を、スタックの積層方向外寸法より小さくする必要があり、実際に締め付けを行う場合には、電池締め付け部品を一旦広げ、その中にスタックを挿入した後、電池締め付け部品を広げている力を解放しなければならない。この際、電池締め付け部品を広げ、かつスタック挿入後に力を解放することを容易にするために、図17に示すように、電池締め付け部品2

5の内側4隅に広げるための切り欠き25aを設けておくことが好ましい。上記した4隅の切り欠き25aに電池締め付け部品25を広げるための棒を差し込み、力を解放した後に棒を引き抜くことによって、容易にスタックを締め付けることが可能となる。また、図14に示したように、スタック18より大面積の剛性部材21を両端面に設置し、電池締め付け部品19とスタック18との間に形成される空間を利用して、電池締め付け部品19を広げると共に、力の解放を容易にすることもできる。

【0120】なお、上述した電池締め付け部品に用いるゴム弾性材料としては、絶縁性を有すると共に、スタックの積層方向に必要な締め付け力が得られるものであれば、種々のゴム材料を用いることができ、例えば生ゴムやテフロン製ゴムが例示される。また、燃料電池の種類によって、耐熱性、耐酸性や耐アルカリ性を有するゴム材料を使用する。

【0121】上述したようなゴム弾性でスタックの少なくとも積層方向を締め付ける電池締め付け部品を用いることによって、従来のボルト締め方式等と比べて、締め付け作業が容易になり、かつ締め付け部品自体の小形、軽量化を図ることができるため、燃料電池の小形化に大きく寄与する。また、締め付け力を容易に調整することができるため、各種の燃料電池に対する対応が容易である。

【0122】また、本発明の燃料電池は、前述したように燃料極2および酸化剤極3における触媒層の有無等に限定されるものではないが、毛管力で燃料極2に液体燃料を供給する構成であるため、燃料極2側の酸化反応の効率を高めると共に、生成するプロトンの移動性を高めることが好ましい。このような要求を満たす方法としては、例えば燃料極2を、耐熱耐酸性の担持体上に概ね互いに重ならないで島状に燃料酸化触媒を存在させ、少なくとも燃料酸化触媒の表面に耐熱耐酸性のプロトン伝導性物質を存在させた燃料酸化触媒粒子で構成する方法が挙げられる。

【0123】上述したような燃料酸化触媒粒子の具体例としては、

(a) 耐熱耐酸性の担持体上に、概ね互いに重ならないで島状に燃料酸化触媒を存在させ、少なくとも該燃料酸化触媒の表面を耐熱耐酸性のプロトン伝導性薄膜で覆った燃料酸化触媒粒子。

【0124】(b) 耐熱耐酸性の担持体上に、概ね互いに重ならないで島状に燃料酸化触媒を存在させ、少なくとも該燃料酸化触媒の表面を耐熱耐酸性を有する高分子ネットワークでプロトン伝導性物質を保持させた薄膜で覆った燃料酸化触媒粒子等が例示される。

【0125】上記(a)および(b)のいずれにおいても、燃料極2は基本的には、燃料酸化触媒を担持したカーボン粒子やTiカーバイド等からなる担持体の多孔質体によ

って構成される。具体的には、上記燃料酸化触媒を担持した担持体からなる燃料酸化触媒粒子を、ポリトラフルオロエチレンのような疎水性樹脂結着剤により保持した多孔質体によって構成する。そして、上記燃料酸化触媒粒子が上記(a)および(b)のいずれかの薄膜に覆われているものである。上記燃料酸化触媒としては貴金属触媒、例えばPt、Pd等の白金族金属と共に、Pt-Ru合金、Pt-Au合金、Pt-Sn合金、Pt-Re合金、Pt-Mo合金、Pt-Ti合金等を用いることができる。

【0126】上記(a)の燃料酸化触媒粒子は、図18に示すように、カーボン粒子やTiカーバイド等の耐熱耐酸性を有する導電性粒子からなる担持体粒子26の表面に、上記したような燃料酸化触媒27を島状に存在させ、この燃料酸化触媒27および担持体粒子26の表面を耐熱耐酸性のプロトン伝導性薄膜28で覆ったものである。プロトン伝導性薄膜28は、少なくとも燃料酸化触媒27の表面を覆っていれば効果は得られるが、図18に示すように、担持体粒子26の表面を含めて全体をプロトン伝導性薄膜28で覆うことによって、担持体粒子26の腐食をも防止することができ、長寿命化を図ることが可能となる。

【0127】上記したプロトン伝導性薄膜28は、耐熱耐酸性の材料であれば有機材料、無機材料を問わない。その中でも、有機系の含フッ素高分子を骨格とするイオン交換樹脂、例えばパーフルオロカーボンスルホン酸樹脂が好適である。また、プロトン伝導性薄膜28の膜厚は、1 μ m以下とすることが好ましい。膜厚があり厚いと、逆に反応を阻害する可能性がある。燃料酸化触媒の表面をプロトン伝導性薄膜で覆う方法としては、上記したようなイオン交換樹脂を溶液化し、これを被覆する方法が一般的であり、かつ簡便である。中でも厚さ1 μ m以下の極めて薄く、かつ均一な薄膜を形成する方法として、溶液化したイオン交換樹脂を用いた電解被覆法が優れている。

【0128】また、上記(b)の燃料酸化触媒粒子は、図19に示すように、上記(a)と同様な担持体粒子26の表面に島状に存在させた燃料酸化触媒27および担持体粒子26の表面を、耐熱耐酸性を有する高分子ネットワーク29内にプロトン伝導性物質30を保持させた薄膜31で覆ったものである。

【0129】上記した高分子ネットワーク29としては、耐熱耐酸性を有すると共に、担持体や燃料酸化触媒との結合力に優れるものであれば種々の高分子材料を用いることができる。担持体や燃料酸化触媒との結合力を考慮すると、特に電解重合によるポリアニリン、ポリピロール、ポリフェニレンサルファイド等が好適である。また、この高分子ネットワーク29中に保持させたプロトン伝導性物質30は、耐熱耐酸性の材料であれば種々の材料を用いることができ、例えばプロトン伝導性を有

するモノマーやポリマーが用いられる。プロトン伝導性モノマーとしては、例えばトリフルオロメタンスルホン酸、テトラフルオロエタンスルホン酸等のフッ素化スルホン酸の誘導体、 $(\text{HO})_2\text{OP}(\text{CF}_3)_2\text{PO}(\text{OH})_2$ 、 $(\text{HO})_2\text{OP}(\text{CF}_3)_2\text{PO}(\text{OH})_2$ 等のフッ素化二リン酸の誘導体、 $(\text{CF}_3\text{SO}_2\text{CH}_2\text{SO}_2\text{CF}_2\text{CF}_2)_2$ 、 $\text{CF}_3\text{SO}_2\text{NHSO}_2\text{C}_4\text{F}_9$ 等のフッ素化スルホン酸の誘導体が例示される。また、同様な性質を有するプロトン伝導性ポリマーとしては、有機系の含フッ素高分子を骨格とするイオン交換樹脂、例えばパーフルオロカーボンスルホン酸樹脂等が例示される。実際上は、ナフィオン117(商品名、デュボン社製)やDOW膜(商品名、ダウ・ケミカル社製)等を溶液化し、これに含まれるポリマー分子を高分子ネットワークに保持させることによって用いる。

【0130】このような高分子ネットワーク29でプロトン伝導性物質30を保持した薄膜31の形成方法としては、上述したような電解重合を用いることが好ましい。例えば、燃料酸化触媒を担持する担持体により、多孔質状の電極基体を作製し、これを電解重合の一方の電極として、高分子ネットワーク材料およびプロトン伝導性物質を含む電解液中に投入し、上記電極と対極間に通電して電解重合を行う。これにより、プロトン伝導性物質を内部に取り込みつつ高分子ネットワークが形成され、かつそのような物質が電極基体内に取り込まれる。このような電解重合によって、担持体上の燃料酸化触媒表面は、高分子ネットワークでプロトン伝導性物質を保持する薄膜によって覆われる。この際、電解重合はパルス状の電流を行って行うことが好ましい。これにより、電極基体の μm オーダーの微細孔内に、効率よくプロトン伝導性物質を保持する高分子ネットワークを取り込ませることができる。なお、プロトン伝導性物質は、燃料電池の電解質中に予め添加しておき、電池反応時に高分子ネットワーク中に取り込ませることもできる。また、膜厚は流す電流で制御可能であり、上記(a)におけるプロトン伝導性薄膜28と同程度とすることが好ましい。上述したような燃料極を用いた燃料電池では、図20に示すように、燃料極中の燃料酸化触媒27の表面を覆う耐熱耐酸性のプロトン伝導性薄膜28や耐熱耐酸性を有する高分子ネットワーク内にプロトン伝導性物質を保持させた薄膜31が、液体燃料の酸化反応により生成したプロトン(H^+)の移動経路として機能するため、毛管現象で燃料極に引き込んだ液体燃料を高効率で反応させることができ、燃料極の高性能化を図ることが可能となる。さらに、プロトン伝導性を有する薄膜28、31中のプロトンの存在によって、燃料を例えばメタノール水系とすることが可能となる。よって、燃料電池構成材料の耐酸性を考慮する必要がなくよりコスト低減に寄与する。また、構成材料の寿命特性も向上する。また、さらにプロトン伝導性を有する薄膜28、31が、ナフィオン117で代表されるような含水性膜の場合に

は、燃料(例えばメタノール+水または希硫酸)を気体として供給しても膜の吸水性により、燃料酸化触媒能を発揮することができる。

【0131】次に、本発明の目的の第一である簡素化かつ小形化された燃料電池の具体例およびその評価結果について述べる。

【0132】実施例1

図1に示した構成を有する液体燃料電池を、以下に示す要領で作製した。まず、平均孔径が $2.0\mu\text{m}$ の $6.0\text{mm} \times 5.0\text{mm}$ の多孔質体を燃料極2として用いると共に、平均孔径が $3.0\mu\text{m}$ の同形状の多孔質体を酸化剤極3として用い、これらで電解質板1を挟持した。これらを、酸化剤ガス供給溝7の形状が深さ 0.7mm 、幅 1.0mm である金属板製のチャンネル兼用セパレータ5を介して、積層数が10となるように積層してスタック6を作製した。なお、酸化剤極3の液体燃料導入路10と接する面の孔は、研磨紙で研磨して塞いだ。また、液体燃料導入路10の形状は隙間 1mm とした。

【0133】このようにして得た液体燃料電池に、液体燃料としてメタノールと希硫酸との混合液を導入したところ、燃料極2全面に液体燃料が供給され、また空気も円滑に流れ、良好に電池反応を進行させることができた。

【0134】また、燃料極2となる多孔質体の内表面に酸化被膜を設けて、同様に燃料電池を作製したところ、より液体燃料の供給を円滑に行うことができ、さらに良好に電池反応を進行させることができた。

【0135】酸化被膜の形成による毛管力の向上を測定するために、以下の試験を行った。表面に酸化被膜を形成した2枚の銅板を、両板の隙間が 1mm となるようにして模擬燃料導入路を作製し、これをメタノール中に浸漬し、酸化被膜のない銅板の場合と比較した。その結果、酸化被膜を有する銅板では、メタノールの上昇高さが酸化被膜のない銅板の上昇高さの約5倍となった。また、同じ距離までメタノールが上昇するまでの時間を測定したところ、酸化被膜を有する銅板は酸化被膜がない銅板の約1/8であった。次に、平均孔径が $2.0\mu\text{m}$ のニッケル多孔質体の内表面に酸化被膜を形成した後、側面以外の表面の酸化被膜を研磨で除去し、これをメタノール中に浸漬して、メタノールの上昇高さが 1.0mm の高さまでメタノールが上昇するまでの時間とを測定した。その結果、酸化被膜を有するNi多孔質体では、酸化被膜のないNi多孔質体に比べて、上昇高さは約3倍、時間は約1/5であった。以上の試験結果から、毛管力の向上に酸化被膜の形成が有効であることが分かった。

【0136】さらに、上記液体燃料電池において、図9に示すごとく燃料極2間に厚さ 5mm のテフロンゴム製シール部材14を配置すると共に、図11に示すごとくゴム製の電池締め付け部材17でスタック6(16)を締め付ける以外は、同様にして液体燃料電池を作製した。

この液体燃料電池に対しても、同様に液体燃料の供給を行ったところ、酸化剤3には液体燃料は侵入せず、シール部材14の効果を確認することができた。また、スタック構成部品間には侵みもなく、電池締め付け部材17の有用性が確認できた。

【0137】実施例2

上記実施例1においては、チャンネル兼用セパレータ5の燃料極側の面に、深さ0.5mm、幅0.5mmの液体燃料供給溝12を設ける以外は、同様の液体燃料電池(図3に示した燃料電池)を作製した。この液体燃料電池に対しても、同様に液体燃料の導入を行ったところ、燃料極2全面に液体燃料がスムーズに供給され、良好に電池反応を進行させることができた。

【0138】実施例3

図4に示した構成を有する液体燃料電池を、以下に示す要領で作製した。まず、平均孔径が20 μ mの60mm \times 50mmの多孔質体に、深さ0.7mm、幅10mmの酸化剤ガス供給溝7を形成すると共に、溝形成面の孔を研磨紙で研磨して塞いで燃料極2とした。また、平均孔径が30 μ mの同形状の多孔質体の側面の孔を研磨紙で研磨して塞いで酸化剤3とした。これらで電解質板1を挟持し、積層数が10となるように積層してスタック13を作製した。なお、液体燃料導入路10の形状は、隙間1.5mmとした。

【0139】このようにして得た液体燃料電池に、液体燃料としてメタノールと希硫酸との混合液を導入したところ、燃料極2全面に液体燃料が供給され、また空気も円滑に流れ、良好に電池反応を進行させることができた。

【0140】また、実施例1と同様にして、酸化被膜の効果およびシール部材14の効果を確認したところ、実施例1と同様に良好な結果が得られた。さらに、酸化剤3に酸化剤ガス供給溝7を形成して、同様な液体燃料電池(図5に示した燃料電池)を作製したところ、同様な結果が得られた。

【0141】次に、本発明における燃料酸化触媒の具体例およびその評価結果について説明する。

【0142】実施例4

燃料酸化触媒の原材料として、100 m²/gの比表面積を有する熱処理済み導電性カーボンブラックVulcan XC-72R(商品名、キャボット社製)に白金触媒を20重量%担持させたものを用意した。この燃料酸化触媒原料の表面に、パーフルオロカーボンスルホン酸樹脂の一つであるナフィオン117(商品名、デュボン社製)を溶液状にしたナフィオン溶液(ナフィオン117を低級アルコールと水の混合溶液に溶かしたもの、濃度約5重量%)を透析することにより得られた希釈ナフィオン溶液(濃度約0.01重量%)を用いて、膜厚約1 μ mのプロトン伝導性薄膜を形成した(以下、修飾触媒と呼ぶ)。

【0143】上記した修飾触媒を、ポリテトラフルオロエチレン水系懸濁液TFE-30(商品名、デュボン社製)中に超音波によって分散させた。次に、この混合懸濁液に三塩化アルミニウムを添加して、綿状の塊を凝集析出させた。この修飾触媒(乾燥重量基準で70%)とポリテトラフルオロエチレンを含む綿状の混合塊を、カーボンペーパー上に担持させ、プレス後乾燥させ、窒素中300℃で20分間焼成して電極とした。得られた電極は、電極単位面積(1cm²)当たり1.5mgの白金を含むように調整した。

【0144】このようにして得た燃料極を用い、かつ1モル硫酸に1モルメタノールを加えた水溶液を液体燃料として、60℃にて燃料極ハーフセル特性を測定した。その結果、燃料極の限界電流密度は100 mA/cm²と、分極特性に優れ、高性能であることが確認できた。

【0145】比較例1

実施例4と同様の燃料酸化触媒の原材料をプロトン伝導性膜で覆うことなく、それ以外は実施例4と同様にして燃料極を得た。得られた燃料極のハーフセル特性を実施例4と同様に測定したところ、燃料極の限界電流密度は60 mA/cm²であった。

【0146】実施例5

実施例4と同一の燃料酸化触媒を用意し、この燃料酸化触媒原料をポリテトラフルオロエチレン水系懸濁液TFE-30(商品名、デュボン社製)中に超音波によって分散させた。次に、この混合懸濁液に三塩化アルミニウムを添加して、綿状の塊を凝集析出させた。この触媒原料(乾燥重量基準で70%)とポリテトラフルオロエチレンを含む綿状の混合塊を、カーボンペーパー上に担持させ、プレス後乾燥させ、窒素中300℃で20分間焼成して電極基体とした。

【0147】次に、上記電極基体を用いて、以下に示す手順にしたがって電解重合を行い、高分子ネットワーク内にプロトン伝導性モノマーが保持された薄膜を、触媒の表面に形成した。なお、高分子ネットワークとしてはポリアニリンを用い、またプロトン伝導性モノマーとしてはトリフルオロメタンスルホン酸を用いた。まず、アニリン1モル/1とトリフルオロメタンスルホン酸2モル/1との混合液からなる電解重合液を収容した電解槽内に、対極と上記電極基体を動作電極として投入した。電解重合液の温度を0℃に保ちながら、2 mA/cm²の定電流で5分間通電した後、さらに20 mA/cm²の定電流で10分間通電して電解重合を行った。このようにして、ポリアニリンネットワーク中にトリフルオロメタンスルホン酸が保持された薄膜を触媒の表面に形成し、燃料極用電極を得た。

【0148】実施例6

実施例5と同様にして作製した電極基体を用いると共に、高分子ネットワーク内に実施例5のプロトン伝導性モノマーに代えてプロトン伝導性ポリマーが保持された

薄膜を、実施例5と同様な電解重合によって触媒の表面に形成した。なお、高分子ネットワークとしてはポリアニリンを用い、またプロトン伝導性ポリマーとしてはナフィオン117（商品名、デュボン社製）を用いた。電解重合の条件は、トリフルオロメタンスルホン酸をナフィオン117に変更する以外は同一とした。このようにして、ポリアニリンネットワーク中にナフィオン117が保持された薄膜を触媒の表面に形成し、燃料極用電極を得た。

【0149】上記により得た実施例5および実施例6の電極の燃料極ハーフセル特性を、実施例4と同様にしてそれぞれ測定した。その結果、実施例5の燃料極の限界電流密度は102 mA/cm²、実施例6の燃料極の限界電流密度は95 mA/cm²と、いずれも分極特性に優れ、高性能であることが確認できた。

【0150】実施例7

実施例5と同様にして作製した電極基体を用いて、以下に示す手順にしたがって電解重合を行った。なお、高分子ネットワークおよびプロトン伝導性モノマーは、実施例5と同材質とした。まず、アニリン1モル/1とホウフ化水素酸2モル/1との混合液からなる電解重合液を収容した電解槽内に、対極と上記電極基体を動作電極として投入し、実施例5と同一条件で電解重合を行った。このようにして、ポリアニリンネットワーク膜を触媒の表面に形成した。

【0151】このようにして得た燃料極を用い、かつ1モル硫酸に1モルメタノールを加えた水溶液にトリフルオロメタンスルホン酸を1 vol%添加したものを液体燃料として、60℃にて燃料極ハーフセル特性を測定した。

【0152】実施例8

実施例7と同様にして作製した電極を用いると共に、1モル硫酸に1モルメタノールを加えた水溶液にナフィオン117を1 vol%添加したものを液体燃料として、60℃にて燃料極ハーフセル特性を測定した。

【0153】実施例7および実施例8の限界電流密度は、それぞれ98 mA/cm²、93 mA/cm²であり、いずれも分極特性に優れ、高性能であることが確認できた。

【0154】実施例9

実施例5と同様にして作製した電極基体を用いて、以下に示す手順にしたがって、実施例5とは若干異なり矩形パルス電流を印加しながら電解重合を行い、高分子ネットワーク内にプロトン伝導性モノマーが保持された薄膜を、触媒の表面に形成した。なお、高分子ネットワークとしてはポリアニリンを用い、またプロトン伝導性モノマーとしてはトリフルオロメタンスルホン酸を用いた。まず、アニリン1モル/1とトリフルオロメタンスルホン酸2モル/1との混合液からなる電解重合液を収容した電解槽内に、対極と上記電極基体を動作電極として投入した。電解重合液の温度を0℃に保ちながら、矩形パル

ス電流を用いて通電電流量5 mA/cm²でパルス電解重合を行った。この時の条件としては、電流密度5 mA/cm²、パルスオンタイム5 msec、パルスオフタイム20 msec (duty cycle: 0.2) である。このようにして、ポリアニリンネットワーク中にトリフルオロメタンスルホン酸が保持された薄膜を触媒の表面に形成して、燃料極用電極を得た。

【0155】実施例10

実施例9と同様にして作製した電極基体を用いると共に、高分子ネットワーク内に実施例9のプロトン伝導性モノマーに代えてプロトン伝導性ポリマーが保持された薄膜を、実施例9と同様な電解重合によって触媒の表面に形成した。なお、高分子ネットワークとしてはポリアニリンを用い、またプロトン伝導性ポリマーとしてはナフィオン117（商品名、デュボン社製）を用いた。電解重合の条件は、トリフルオロメタンスルホン酸をナフィオン117に変更する以外は同一とした。このようにして、ポリアニリンネットワーク中にナフィオン117が保持された薄膜を触媒の表面に形成し、燃料極用電極を得た。

【0156】上記により得た実施例9および実施例10の電極の燃料極ハーフセル特性を、実施例4と同様にしてそれぞれ測定したところ、これらの燃料極の限界電流密度は、それぞれ105 mA/cm²、103 mA/cm²であり、いずれも分極特性に優れ、高性能であることが確認できた。

【0157】実施例11

実施例5と同様にして作製した電極基体を用いて、以下に示す手順にしたがって電解重合を行った。なお、高分子ネットワークおよびプロトン伝導性モノマーは、実施例9と同材質とした。まず、アニリン1モル/1とホウフ化水素酸2モル/1との混合液からなる電解重合液を収容した電解槽内に、対極と上記電極基体を動作電極として投入し、実施例9と同一条件で電解重合を行った。このようにして、ポリアニリンネットワーク膜を触媒の表面に形成した。

【0158】このようにして得た電極を用い、かつ1モル硫酸に1モルメタノールを加えた水溶液にトリフルオロメタンスルホン酸を1 vol%添加したものを液体燃料として、60℃にて燃料極ハーフセル特性を測定した。このハーフセル特性は、実施例7とほぼ同等の特性が得られた。

【0159】実施例12

実施例11と同様にして作製した電極を用いると共に、1モル硫酸に1モルメタノールを加えた水溶液にナフィオン117を1 vol%添加したものを液体燃料として、60℃にて燃料極ハーフセル特性を測定した。このハーフセル特性は、実施例8とほぼ同等の特性が得られた。

【0160】以上説明したように、本発明の燃料電池によれば、ポンプやブロー等を用いることなく、液体燃料

および酸化剤ガスを円滑に供給することができる。これにより、システムの簡易化と構造の簡素化が達成でき、よって従来困難とされていた小形の燃料電池を提供することが可能となる。

【0161】次に、本発明の目的の第二の、即ち燃料電池の動作に伴って生成する水の排出に関する本発明の実施態様を以下に述べる。

【0162】図面を用いて本願発明に適した小形燃料電池の一例を示す。

【0163】小形燃料電池の構造の一例を示す斜視図を図21に示す。基本的には燃料電池本体32と、燃料カートリッジと33、燃料拡散室34および発生する水の回収及び拡散を容易にするための水回収室35とからなっている。以下、これらの構成内容を詳細に説明する。

【0164】図22に燃料電池本体32の斜視図を示す。燃料電池本体32は図22に示すような燃料電池の発電部が積層された積層構造となっている。図22に示すように燃料電池本体32は電解質36、燃料極37、酸化剤極38、からなる起電部が積層され、各起電部はセパレータ39で分離されている構成となっている。

【0165】酸化剤極38は、生成した水を吸収するため多孔体より成っている。また燃料極37も特別な動力なしに燃料の供給を行うために、多孔体構造とし毛細管現象を利用してメタノール等の液体燃料供給を行うことが燃料電池の小形化を行う上好ましい。

【0166】また、図21において35は水回収室で、発生する水の回収を容易にするための部所であり、この中に多孔体（水回収ウィック）を配置する。

【0167】水回収ウィックは、酸化剤極38に接する様設計されている。また水回収ウィックは、酸化剤極よりも平均細孔径が小さい多孔体を用いられている。

【0168】燃料供給は燃料カートリッジ33を用いて行う。図23に図21に示した燃料電池の断面図を示す。カートリッジ33は燃料収納スペース40と水収納スペース41の2室に分離し、それぞれ燃料（水を同時に必要分だけ含む）と燃料電池本体から生成する水を入れることができる。水収納スペースの内部41には無機または有機繊維等からなる多孔体を予め入れておく。前記水回収室内35のウィックは、燃料カートリッジを装置した際には燃料カートリッジ内の水収納スペース410の水保持ウィックと接するようにする。このとき水保持ウィックは前記水回収ウィックよりも平均細孔径が小さい多孔質体を用いる。

【0169】このような構造をとることで、生成した水は最終的に燃料カートリッジ33へ回収される。水回収室35は独立に存在しなくてもよく、燃料電池本体の構造中に形成することもできるが、この場合でも水回収ウィックはその中に配置しておくことが必要である。

【0170】一方、燃料の供給についても毛細管現象を

利用して行う場合には以下に示す構造にすることが好ましい。燃料電池本体の燃料導入側面には燃料拡散室34を設け、この中に無機あるいは有機繊維等からなるウィックを入れておく。ウィックは燃料極の燃料導入面と接しており、燃料カートリッジから供給される燃料は一度この燃料拡散室34のウィックに供給されてから、毛細管の作用で燃料極へ分配される。なお、燃料拡散室34は必ずしも燃料電池本体と別置に存在する必要はなく、燃料電池本体の構造中に形成しておいてもよい。また、燃料拡散ウィックは必ずしも配置しなくてもよく、液体状態の燃料が燃料電池本体の燃料導入面に直接送られてもよい。

【0171】上述したような燃料カートリッジは燃料本体に装着・脱着自在な構造とすることが好ましい。装着したときには燃料収納スペースと燃料拡散室の燃料拡散ウィックが接触して燃料が供給され、同時に水回収室の水回収ウィックと水収納スペースの水保持ウィックとが接触できるような構造とする。逆に、脱着した場合は、それらの接触がたたり、燃料カートリッジ側と燃料分散室および水回収室側とが遮断され、それぞれが外界と遮断できるような構造とする。

【0172】以上のような形で燃料の供給又は水の回収に使用される多孔体（ウィック）は、毛細管の作用、すなわち表面張力の作用で液体を吸引する構造となっており、このとき、それぞれの多孔体を、その平均細孔径の値が液体の流れ方向に向かって、徐々に小さくなるように配置することで、液体の流れをスムーズにする。平均細孔径が小さくなることはそれだけ表面張力によって液体を引っ張る力が大きくなる。したがって、多孔体を連続的に配置し、それぞれの多孔体の平均細孔径が徐々に小さくなるようにすれば、その方向に向かって液体はスムーズに流れることになる。

【0173】この場合、たとえば、燃料供給経路に関しては、燃料拡散ウィック（無機・有機繊維など）の平均細孔径を100 μ m程度、燃料極（ニッケル等の金属多孔体）を30 μ m程度とする。一方、水の回収経路に関しては、酸化剤極（ニッケル等の金属多孔体）の平均細孔径を50 μ m程度とし、水回収ウィック（無機・有機繊維など）は30 μ m程度としておくことで、それぞれの流体に関してその必要な方向への流動をスムーズに行える。これらのウィックの平均細孔径は保持させるべき燃料電池の性能に合わせて適宜、変えることができる。

【0174】また、このとき、多孔体の多孔度は、流体の流れ方向に向かって徐々に小さくなるように配置することが好ましい。多孔度が大きくなると、多孔度中に保持可能な流体の体積が多くなり、流体の移動速度を速やかにすることができる。ただし多孔体に関しては、平均細孔径(D)、比表面積(Sp)、多孔度(E)は、 $D = (1/Sp) \cdot (4E/(1-E))$ の関係にあり、上記の関係式を満たす様、多孔体の比表

面積及び多孔度を決定する必要がある。

【0175】上記の前述の燃料電池の構成例には回収した酸化剤極からの水を、燃料カートリッジ中の水収納スペース中に回収する小型燃料電池について示したが、場合によっては、回収した水を、燃料電池の外部に散逸させることもあり得る。

【0176】図24に酸化剤極より回収した水を外部に散逸させる場合の小型燃料電池の構成の一例を示す斜視図を示す。

【0177】具体的には、燃料電池本体32と、燃料カートリッジ33と水散逸機構43と動力器44水回収室35（図示せず）より成る。また、一対の正極及び負極の端子42を適当な位置に配置している。燃料電池本体32は、図22に示される燃料極、酸化剤極、電解質層からなる起電部が積層されている。

【0178】水散逸機構43は、酸化剤極で生成した水を散逸させるための機構を収納している。動力器44は、水散逸機構を動作させるための動力器、あるいは電子回路を収納している。図25は、図21を燃料カートリッジ33の方向から見た燃料電池を、燃料電池本体1が存在する場所で切断した場合の断面を示す。

【0179】4は水回収室であり、酸化剤極で発生する水の回収及び拡散を容易にするための部所で、この中に多孔体（ウィック）を配置する。水回収ウィックは酸化剤極よりも平均細孔径が小さく燃料電池本体32中の酸化剤極に接する様設けられている。

【0180】図25に示した水回収室35へ送られる水は、水蒸気と水の両者が含まれ、燃料電池の運転条件によってその存在量比が異なる。水蒸気についてはそのまま散逸するので問題はなく、いま問題としているのは水の形態で生成するものである。水回収室35内に存在させた多孔体（水回収ウィック）は、多孔度が50%以上になるようにし、水拡散機構によって多孔の間に捕獲された水が散逸しやすい状況にしておく。

【0181】水の散逸機構43としては、小型の横流ファンを備え、これを作動させて水の散逸を行う方法が適用できる。

【0182】また小形の横流ファンのかわりに圧電体からなる振動素子を備えその振動によって生成水を霧散させてもよい。

【0183】またヒータ機能を設けて生成水の一部を加熱させて体積膨脹させ、これにより、排水弁を作動させ残りの生成水を強制的に排出させてもよい。

【0184】圧電体からなる振動素子は生成水を霧散させるが、気化させないので気化熱は必要としない。圧電体からなる振動素子自体は極めて小型薄型に伴うことができる。したがって小型高効率という特徴を損なうことができる。

【0185】生成水の一部だけを気化させる方法では、全部気化させるのに比較して格段に少ないエネルギーで

ずむ。

【0186】次にこれまでに述べてきた構成の燃料電池の動作をスムーズに行われるようにするために好ましい燃料極、電解質層、酸化剤極の詳細な構造を図26に示す。

【0187】燃料極37に関しては、燃料の導入面45はスタックする方向を除いた4側面のうち1側面だけとし、この面から対向する面の方向に向け、電解質層36と接する燃料極37平面上の途中から炭酸ガスを逃がすための複数個の溝46を形成する。燃料は多孔体の中を毛細管によってスムーズに運ばれて全面に拡散し、反応によって生じた炭酸ガスは溝46を通して外部に運ばれる。この場合、燃料が外部へ漏洩することを防止するために、燃料供給を行わない他の3側面47、48、49の表面孔を閉塞しておく。

【0188】一方、酸化剤極38も同様な多孔体で構成するが、この場合は、燃料極の燃料が導入される方向と同一側面50の表面の孔は完全に閉塞しておき、この面からの燃料の進入を防ぐ。そして、電解質層36と接する側の酸化剤極面には直行する方向に複数の溝51を形成し、この溝の切込みは孔を閉塞した側面以外の3側面52、53、54まで届くように形成しておく。この3側面は空気を取り込むためのものであり、少なくともそのうち2側面以上から実質的に空気を取り込むようにする。ここで酸化剤極で生成する水は多孔体の孔を閉塞した面と隣合う一つの側面（この場合、54）から逃がすようにする。空気を3側面から取り入れる構造は、酸素の濃度を高めて燃料極反応よりも速い酸化剤極反応速度を上げるためである。

【0189】以上、本願発明の酸化剤極に生ずる水の回収、排出を含めた小形燃料電池の例について述べてきた。上記の例においては、いずれも燃料電池本体への燃料の供給に燃料カートリッジを用いて小型、携帯機器に適した構造となっている。

【0190】機器によって必要とする電圧が異なる場合があり、高い電圧を要する場合は、積層する燃料電池の起電部の数を増加させる必要がある。または、機器によっては発電体の形状に対する要求から、燃料電池を一例の配置のみでは済まされないことがある。その場合は、図27に示すように、燃料カートリッジ33の収納位置の周囲に燃料電池本体32の燃料供給面が集まる構造とし、その燃料拡散室34が設置されるようにする。このことにより、燃料供給の通路が短くなると同時に、水回収室35からの距離も近くなり、信頼性の高い発電体を得られる。

【0191】本願発明によれば特別な動力を用いることなく酸化剤極上に生成した水はすみやがに除去され、効率良く燃料電池の運転を継続させることができる。

【0192】特に固体高分子膜を電解質として用いた場合には、作動温度が100℃以下であり、生成する水は

ほとんど液体状であるが本発明によれば、液体状態の水は特にすみやかに除去することができる。また、燃料電池を傾ける、逆さにする等動いた場合にも一旦回収した水の飛散・逆流は防止でき、小型、携帯用機器の電源として適した燃料電池となる。

【0193】また前述したように、燃料の供給にも多孔質体による毛細管現象を利用した燃料供給法を用いた燃料電池は、燃料の供給、水の排出にも特別な動力を必要としないため、いっそう小型化が可能となる。

【0194】本発明の第3の目的を達成するための発明は、燃料極と酸化剤極およびこれら両電極に挟持された電解質層を有する起電部を備え、複数の起電部が直列に接続され、各起電部の燃料極が共通の燃料流路から燃料が供給されかつ各起電部の燃料極の電極面が前記燃料流路に面しているか、または、各起電部の酸化剤極が共通の酸化剤流路から酸化剤が供給されかつ各起電部の酸化剤極の電極面が前記酸化剤流路に面している構造の燃料電池であって、前記電解質層が吸水性もしくは保水性物質を含有していることを特徴とする燃料電池である。

【0195】図28に図示した燃料電池の構成図により、以下に説明する。

【0196】本発明に係る燃料極と酸化剤極およびこれら両電極に挟持された電解質層を有する起電部を備え、複数の起電部が直列に接続され、各起電部の燃料極が共通の燃料流路から燃料が供給されかつ各起電部の燃料極の電極面が前記燃料流路に面しているか、または、各起電部の酸化剤極が共通の酸化剤流路から酸化剤が供給されかつ各起電部の酸化剤極の電極面が前記酸化剤流路に面している構造の燃料電池とは、例えば、図28に示される様に酸化剤極38、燃料極37、及び電解質層60から構成される起電部55を、燃料極が同一面上にある様に横並びに並べ、隣り合った起電部55の燃料極37と酸化剤極38を、接続用導電体57で接続することにより直列に接続した構造が挙げられる。このような構造の電池においては、燃料は両起電部共、共通の燃料流路58から燃料極37の電極面に供給される。また、酸化剤である空気は、両起電部共通の酸化剤流路59から酸化剤極38の電極面に供給される。

【0197】またこの他にも、円筒型の起電部を直列に接続した構造の燃料電池が挙げられる。図29に本発明に係る別の燃料電池の断面構成図を示す。起電部55は円筒状であり円筒の内側から燃料極37電解質層36、酸化剤極38が形成されている。

【0198】1つの起電部55は外側の酸化剤極38が別の起電部の内側にある燃料極37と接する様、重ねられて構成されている。このような構造の燃料電池において燃料は円筒の内側に形成される燃料流路58に供給され燃料極37の電極面に供給される。酸化剤である空気は、円筒の外側から酸化剤極38に供給される。また燃料極を円筒の外側とし、酸化剤極を円筒の外側にし、円

筒の外側から燃料を供給する構造もある。

【0199】図44に本発明に係る別の燃料電池の斜視図を示す。

【0200】1つの起電部55は円筒状であり円筒の内側から燃料極37、電解質層36、酸化剤極38が形成されている。このような円筒状の起電部55が複数個、接続用導電体57により直列に接続されている。このような構造の燃料電池において、燃料は円筒状の各起電部の内側に形成される燃料流路58に供給され、燃料極37の電極面に供給される。酸化剤である空気は、円筒の外側の、各起電部共通の酸化剤流路59から酸化剤極38表面に供給される。また、このように円筒状の起電部を並べた構造の燃料電池において、燃料極を円筒の外側とし、酸化剤極を円筒の外側となる様に構成し、円筒の外側の各起電部共通の燃料流路から燃料を供給する構造もある。

【0201】従来燃料極に供給する燃料、又は酸化剤極に供給する酸化剤等の反応物質に水や電解質を混入させることは不可避であり、これらがイオン伝導体となる電解質として作用するため、通常上記のような構成の燃料電池では複数の起電部間の電圧ロスも除去不可能なものとされてきた。

【0202】この問題を解決する手段として、本願発明においては、起電部の電解質層として通常の電解質の主構成物質であるイオン交換膜を有する化合物の他に膜内に水分を供給・保持し、あるいは濃度勾配にしたがって水分を通過させる保水性もしくは保水性物質を並置させたものを用いていることを特徴としている。

【0203】本発明の燃料電池に用いる電解質層の構成及び機構を模式図によって説明する。図30にプロトン導電性の固体高分子を用いた電解質層の構造模式図を示す。図30において、電解質層60は、固体高分子電解質61内に吸水性もしくは、保水性物質62が保持されている。

【0204】図31にこの電解質内での物質移動の模式図を示す。図31で明らか olmayan 本発明に係る電解質層は高分子固体電解質本来のイオン（プロトン）導電性を示すと共に、吸水性もしくは保水性物質の働きにより自ら吸水性ないし保水性を示すため酸化剤表面で生成した水を速やかに吸収して電極に常に反応物質と接触できる状態に保ち、同時に膜内および燃料極表面の乾燥を防止する働きも示す。

【0205】つまり、燃料極側で生成したプロトンは、固体高分子電解質のプロトン導電性により参加剤極側（矢印63の方向）に輸送される。また、酸化剤極側で生成した水は、吸水性もしくは保水性物質の働きにより、矢印64のごとく、燃料極表面及び電解質内に送られ水分が保持される。

【0206】以上のように本発明に係る電解質層は自ら吸水性ないし保水性を示すため一方の電極触媒表面で生

成した水を速やかに吸収して触媒表面を常に反応性物質と接触できる状態に保つ共に、吸収した水は電解質中に濃度勾配にしたがって拡散し、他方の電極表面の乾燥を防止する働きも示す。さらにこの過程において電解質自体も外部からの水分の添加無しに常に有効なイオン解離、イオン伝導特性を維持できるといった優れた性質を示す。

【0207】したがって、この電解質層を用いた燃料極では、供給する反応物質中には水を混入させずに電解質中に水を供給出来、また、酸化剤極において生じた水はすみやかに吸収されるため、電解質層以外でのイオン伝導を小さく抑えることができる。

【0208】本発明に係る吸水性もしくは保水性物質としては、澱粉、アクリロニトリル共重合体、架橋アクリル酸塩、架橋ポリエチレンオキサイド等の吸水性高分子化合物、シリカヒドロゲル、変成蛋白質（ゼラチン）等のゲル状化合物などが利用できる。

【0209】また、電解質としては、固体高分子電解質の場合に本願発明の顕著な効果を得られる。

【0210】固体高分子電解質としては、プロトン導性固体高分子電解質として、パーフルオロカーボンスルホン酸ポリマー（商品名：Nafion[®]（米国Du Pont 社製）スルホン酸基を有するポリスチレン系の陽イオン交換膜が挙げられる。このような起電部を用いることにより、本発明の骨子である酸化剤および燃料極に供給する反応物質のいずれの中にも電解質として作用する物質を不可避混入量以上は含まず、かつ複数の起電部の端部を互いに直列に接続した構成である燃料電池を実現することができる。

【0211】次に、複数の発電素子の端部を互いに直列に接続する方法としては各発電素子の集電体を溶接・導電性接着剤などにより直接接続する方法、反応物質の混合や漏れ電流を防止するために導電板などを介して接続する方法、あるいは起電部を作製する際に複数の起電部を予め直列接続されるように一体化させて作製する方法などが採用できる。

【0212】さらに、これらの方法において電解質の漏れを抑えるために複数の起電部の接続部分を撥水処理することも有効である。

【0213】次に本願の目的の第4に関する発明について以下に説明する。本発明はメタノールなどの炭素含有燃料を燃料極に直接供給する。例えばメタノール燃料電池に係り、燃料極に前記炭素含有燃料供給した際に生じる燃料極表面の被毒を抑制するためのものである。

【0214】本願の第4の目的に関する発明は、燃料極と酸化剤極及びこれら両電極に支持された電解質層を備えた燃料電池において、燃料極をアノードに分類させる機構を備えたことを特徴とする燃料電池である。

【0215】すなわち本発明においては、燃料電池の運転時に燃料極表面の被毒生成物を生じた場合に、燃料極

に対極を接続し、アノードに分類させ前記被毒生成物を酸化除去するものである。それにより、長時間安定した出力の得られる燃料電池となる。

【0216】さらに通常燃料電池においては、燃料極、酸化剤極電解質極からなる起電部を複数個直列に接続して用いている。この場合は、前記分極操作を各発電部ごとにローテーションして行うことが好ましい。運転を中断することなく、被毒生成物の除去が行える。

【0217】以下に本発明の第2、第3および第4の目的を達成する本発明の燃料電池に関して、実施例を説明する。

【0218】実施例13

図24に示すような燃料電池による発電体を構成した。定格としては作動電圧3V6Wで10hの容量（60Wh）とした。燃料電池本体中に積層された起電部の数は8個である。各起電部の構造は図22に示す通りである。

【0219】固体高分子電解質36は厚さ100 μ mの商品名ナフィオンを使用し、その両側の表面に白金触媒を無電解メッキ法により付着させ、PTFE（テフロン）の分散液をスプレーにて適量付与した。その両側から図22に示す構造の燃料極37および酸化剤極38を配置して、ニッケル板からなるセパレータ39を用いた、燃料極37、酸化剤極38とも板状Niの多孔体を使用し、燃料極は細孔径分布が40～60 μ m程度の範囲にあり、中央値で50 μ mの程度の平均細孔径を持っている。カソードは同様に50 μ m程度の平均細孔径をもっている。なお、固体高分子電解質層と接する燃料極と酸化剤極の表面には、やはり白金の触媒と適量のPTFEを付与した。燃料極37の燃料を含浸させる面と同一面にある酸化剤極と固体高分子電解質膜36およびセパレータ39の側面は、（酸化剤極についてはその面の孔を閉塞した後）耐アルコール性の保護膜を塗布して、そこからはアルコールが侵入しないようにした。図25に図21に示した燃料電池の断面図を示す。

【0220】燃料拡散室34は樹脂製で、この内部に樹脂性繊維多孔体（材質フッ素樹脂の微粒子とポリエステル布織物の複合材料で、平均細孔径100 μ m程度）からなる燃料拡散ウィックを入れておく。一方、水回収室35はやはり同一材料の樹脂性多孔体（平均細孔径40 μ m程度、多孔度50%程度）の水回収ウィックを挿入しておく。水散逸機構43としては横流ファンを使用した。

【0221】燃料カートリッジにはモル数比で、メタノール：水＝1：2を入れた（理論的には1：1であるが固体高分子電解質をウェットに保持するために倍量とした）。

【0222】比較例2

比較例2として、次のような発電体を構成した。すなわち、実施例13と同様の構成の発電体であるが、酸化剤

極38、水回収ウィックの平均細孔径がやはり $50\mu\text{m}$ を用いた構造の燃料電池を構成した。

【0223】比較例3

比較例3として、次のような発電体を構成した。すなわち、実施例13と同様の構成の発電体であるが、水回収ウィックを取り付けなかった点が異なった燃料電池を構成した。

【0224】以上の電池を常温で、2A放電にて作動させた結果を図32に示す。比較例2、比較例3では放電が短時間で終了し、定格どおりの特性が出なかった。これは生成した水が十分に速く燃料電池本体から取り除かれないうちに、水が滞留し後続の反応を阻止したためと考えられる。

【0225】これらに対して実施例13では定格どりの放電が可能であった。放電中に電圧が少しづつ低下したが、全く問題のないほどであった。さらに、燃料がすべて使用し尽くした。

【0226】なお、上記実施例で述べた材料は、それだけで留まらず、多くの材料が使用可能である。例えば、燃料極や酸化剤極に使用する材料は、ニッケル金属に限らず、耐酸性のある材料、例えば、ステンレス系材料、アルミニウムないしは銅をベースにした合金、あるいはタングステン、チタン等のパルプ金属材料でもよく、さらには炭素材料、あるいはSiC等の複合材料からなる多孔体であればよい。あるいは樹脂多孔体の表面を適当な耐酸性の金属等で被覆した材料でもよい。その場合、多孔度としては30～80%程度、平均細孔径としては $1\mu\text{m}$ から $100\mu\text{m}$ 程度が適当である。これらの下限値以下になると実質十分な多孔を実現できなくなり、液体が含浸して行かないようになる。また上限値を越えると材料の機械的強度が低下し、また多孔そのものが大きくなりすぎて液体保持材料としての意味がなくなる。

【0227】また、ウィックについても、材質は種々のものが使用可能であり、概ね親水性の材質が液体を運ぶためには好ましい。但しこの場合、ショート液路や短絡の原因になるので、材質には導電性はあってはならない。樹脂では、フェノール樹脂、ポリエステル樹脂、天然セルロース等のフェルト、不織布、織布などが好ましい。多孔度としてはやはり、下限は30%程度、上限は95%程度が好ましい。

【0228】この場合は下限値以下では実質上の液体保持量が低下し、上限値以上では液体保持力が低下してウィックの役割を果たさなくなる。

【0229】実施例14

市販のパーフルオロカーボンスルホン酸ポリマーからなる固体高分子電解質膜（商品名：Nafion；米国Du Pont社製）の溶液（Aldrich社製）と吸水性ポリマーである澱粉、ポリアクリル酸ナトリウム重合体の低分子量オリゴマー水溶液とから製膜した。製膜は高分子電解質と吸

水性ポリマーが固形分比率9：1になるように両溶液をガラス板上で混合・展開した後、加熱処理して重合の完結と乾燥を行った。この膜の両面に白金担持カーボン粉末とフッ化炭素の混合物からなる触媒層と集電体としてニッケルメッシュを熱圧着し、起電部とした。

【0230】実施例14では 10cm 、 3cm の寸法にこの起電部を4個作製し、各々の長端辺にニッケルリボンを通して接続し、平面4直列の発電体を作製した。図33にこの発電体の概形を示す。図33において、37は燃料極、38は酸化剤極、60は固体高分子電解質と吸水性ポリマーからなる電解質層、57はニッケルリボンからなる接続用導電体である。図34は上記起電部間の接続部を示す断面図である。図34において37は燃料極、38は酸化剤極、60は電解質層、56は集電体、57は接続用導電体である。集電体56と、接続用導電体57との接続部分はテフロンディスページョン65を塗布、焼付して撥水処理をほどこした。この発電体を用いて模擬燃料電池を製造した。その模式図を図35に示す。まず、上記発電体66を模擬セル容器67に収納し、電極両面に空気および燃料を供給するための空気室38、空気入口69、空気出口70及び燃料室71、燃料入口72、燃料出口73を設け、模擬燃料電池を作成した。電極両面に空気および燃料を供給して発電特性を試験した。

【0231】実施例15

実施例15では実施例13と同様に作製した発電体の起電部間の接続部分の全面にテフロンディスページョン65を塗布・焼き付けて撥水処理を行ない、模擬燃料電池を作製した。この場合の接続部分の模式図を図36に示す。

【0232】実施例16

また、図37に示すようにニッケルメッシュを二つの起電部間で共通に使用するようにしたものは実施例13と同様に発電体を作りこれを実施例16とした。

【0233】以上実施例14～16の模擬燃料電池の燃料室に水素ガスを空気に空気を供給した場合の開放電圧と $0.2\text{A}/\text{cm}^2$ 通電時の電圧を表1に示す。

【0234】比較例4

固体高分子電解質中に吸水性ポリマーを含まない以外は、実施例8と同じ模擬燃料電池を用い、その燃料室に 80°C の温水中に通過させた水素ガスを供給した他は実施例13と同様の方法で電圧を測定した結果を表1に併記する。

【0235】比較例5

実施例12～14に用いたのと同じ発電素子を $5\text{cm} \times 5\text{cm}$ の寸法に切断し、正負両極室となる2枚のニッケル粉末の多孔性焼結板で挟んだ。これを4組作製し、各々の間にニッケル板を挟んで積層して模擬燃料電池を作製した。この模擬燃料電池についても燃料極側に水素ガスを酸化剤極側に空気を供給した場合の電圧を測定し、表1

に示す。

【0236】

【表1】

番 号	開路電圧 (mV)	200 mA/cm ² 閉路電圧 (mV)
実施例14	405	285
実施例15	415	300
実施例16	405	290
比較例4	385	265
比較例5	400	280

また、実施例14と比較例4の模擬燃料電池についての【0237】

およその寸法比較を行い、結果を表2に示す。

【表2】

番号	単位発電 素子面積 (cm ²)	200mA/cm ² 時 出力 (mW)	模擬燃料 電池体積 (cm ³)	発電素子面積 当りの体積 (cm)	出力当りの 体積 (cm ³ /W)
実施例14	30	57	約12	0.4	211
比較例4	25	56	約31	1.24	554

以上のように、本発明の燃料電池は同数の発電部を積層しても比較例のような従来型の積層方法もしくは従来行われてきたようなイオン導体となり得る濡潤反応物質を供給する場合より高電圧で、かつ体積的にも小さく有利であることが分かる。

【0238】さらに、実施例14の模擬燃料電池の燃料

室に60℃に加熱したメタノールを供給して直接発電を行った場合と、メタノールに同体積の水を加えて同様の発電を行った場合の電圧を表3に示す。

【0239】

【表3】

供給燃料	開路電圧 (mV)	60 mA/cm ² 閉路電圧 (mV)
メタノール	2.80	1.65
メタノール+水(1:1)	2.70	1.50

表3に示されるように、燃料極メタノールを供給した場合でも燃料電池が作動することがわかる。したがって、本発明の燃料電池は、各電極部間の電圧をロスの原因となる水を燃料と共に供給する必要がなく、電圧ロスを低減することができることは明らかである。

【0240】実施例17

まず図38に示す燃料電池を試作した。起電部74は固体高分子電解質75を挟んで燃料極76と酸化剤極77を配した構造となっており、さらにその外側にはそれぞれ燃料室71および空気室68を設けてある。また燃料室71内には、燃料極をアノードに分極させるときの対極78が設置してある。ここで、燃料極、酸化剤極および対極にはすべて白金を、固体高分子電解質には市販のパーフルオロカーボンスルホン酸ポリマー（商品名：Nafion[®]；米国Du Pont 社製）を用いた。アノードとしてはメタノール1mol / 1、硫酸1mol / 1の水溶液を用いた。

【0241】このセルを用いて20 mA/cm²の電流密度で放電特性を調べた。このとき100分ごとに放電を中断して、2Vの外部直流電源79に燃料極76と対極78をつなぎ、3分間分極操作を行い、電極をリフレッシュさせた。

【0242】比較例6

比較として、この分極操作を行わないものについても放電特性を調べた。

【0243】結果を図39に示す。連続して放電を行った比較例6では、時間の経過と共に出力電圧が低下して行くのに対し、途中に分極操作を行った実施例5の場合は100分経っても高い出力電圧を維持している。

【0244】実施例18 比較例7

実施例17の起電部を10セル積層した電池を試作した。この積層セルについて、実施例17と同条件で放電特性を調べた。ただしこの場合、リフレッシュ操作は、放電中の各セルのうちから、セルを1つだけ放電回路か

ら外して分極させ残りのセルは放電を続けられるようにし、この動作を各セルでローテーションさせ、出力が中断しないようにした。また分極のための電源は、積層しているセルから取り、外部の電源を用いていないでも良いようにした。システムの概要と回路を図40に示す。この図では、No. 3セルをリフレッシュしている例を示した。すなわち、放電回路からNo. 3セルをはずすため、スイッチ(A)を切り換え、さらにセルの燃料極を分極するため、スイッチ(B)を切り換え、放電中にNo. 4, No. 5, No. 6のセルから並列に電源を取り一定時間分極させた。そしてこのスイッチング操作を積層した各セルでローテーションさせた。分極は、実施例11と同様100分間ごとに5分間行った。なお図中破線ワケ内のスイッチング回路は、集積回路にまとめ小型化することができる。

【0245】このように構成した電池と、比較として(比較例7)、全く分極操作を行わないものについてその放電特性を図41に示す。

【0246】実施例17と同様に、実施例18の場合も、1000分経っても高い出力電圧を連続して維持している。

【0247】

【発明の効果】以上詳述した如く、本願発明によれば、小型化に適した高効率な燃料電池を提供することができる。

【0248】すなわち、本願の目的の第2に関する発明によれば、特別な動力を用いることなく、酸化剤極表面に生じた水をすみやかに回収することができる。しかも、多孔体を用いて吸収するため、可動式の電源として使用しても、回収した水の逆流、飛散などが生じないため、小型機器用の電源として適した構造である。

【0249】また、本願の目的の第3に関する発明によれば、小型化に適した横並び型、円筒型等の構造の燃料電池において、発明部間の電圧のロスが減少し高効率の電源を得ることができる。

【0250】また、本願の目的の第4に関する発明によれば、小型燃料電池の燃料として適したメタノール燃料を用いた場合に、燃料表面の被毒現象を抑え、長時間安定した出力の得られる燃料電池が実現できる。

【図面の簡単な説明】

【図1】本発明の一実施例によるセパレータを有する燃料電池の要部構成を示す一部切り欠き斜視図。

【図2】図1に示すチャネル兼用セパレータの変形例を説明するための図。

【図3】本発明のセパレータを有する燃料電池の他の実施例の要部構成を示す一部切り欠き斜視図。

【図4】本発明の一実施例によるセパレータを省いた燃料電池の要部構成を示す一部切り欠き斜視図。

【図5】本発明のセパレータを省いた燃料電池の他の実施例の要部構成を示す一部切り欠き斜視図。

【図6】本発明のセパレータを省いた燃料電池のさらに他の実施例の要部構成を示す一部切り欠き斜視図。

【図7】図3に示す燃料電池の変形例の要部構成を示す一部切り欠き斜視図。

【図8】図4に示す燃料電池の変形例の要部構成を示す一部切り欠き斜視図。

【図9】図7に示す燃料電池をさらに変形させた例の要部構成を示す断面図。

【図10】本発明の燃料電池の変形例の要部構成を示す一部切り欠き斜視図。

【図11】本発明の燃料電池の締め付け構造を示す一部切り欠き斜視図。

【図12】本発明の締め付け構造を有する燃料電池の構成を模式的に示す図。

【図13】本発明による燃料電池の締め付け構造の他の例を模式的に示す図。

【図14】図12および図13に示す燃料電池の締め付け構造の変形例を示す図。

【図15】本発明による燃料電池の締め付け構造のさらに他の例を示す図。

【図16】本発明による燃料電池の締め付け構造のさらに他の例を示す図。

【図17】電池締め付け部品の変形例を示す図。

【図18】本発明の燃料電池における燃料酸化触媒粒子の一例の要部構成を示す断面図。

【図19】本発明の燃料電池における燃料酸化触媒粒子の他の例の要部構成を示す断面図。

【図20】本発明の燃料電池に用いられる燃料酸化触媒での電極反応を説明するための断面図。

【図21】本発明の水回収機構を含む小形燃料電池の構成を示す斜視図。

【図22】図21の小形燃料電池に使用される燃料電池本体の斜視図。

【図23】図21の小形燃料電池の構成を示す断面図。

【図24】本発明の水回収機構を含む小形燃料電池の構成を示す斜視図。

【図25】図21の小形燃料電池の構成別の方向からみた断面図。

【図26】本発明の水回収機構を含む小形燃料電池の燃料極、電解質層、酸化剤極の構成を示す斜視図。

【図27】本発明の水回収機構を含む小形燃料電池の構成を示す斜視図。

【図28】本発明の燃料電池の起電部の配列構成の一例を示す構成図。

【図29】本発明の燃料電池の起電部の配列構成の一例を示す構成図。

【図30】電解質層の構造模式図。

【図31】電解質層中の物質移動を示す模式図。

【図32】本発明の実施例13及び比較例3および4に係る燃料電池の時間-電圧特性図。

【図 3 3】 実施例 1 4 に係る発電体の概略図。

【図 3 4】 実施例 1 4 に係る発電体の接続部分の概略図。

【図 3 5】 実施例 1 4 に係る模擬燃料電池の断面図。

【図 3 6】 実施例 1 5 に係る発電体の接続部分の概略図。

【図 3 7】 実施例 1 6 に係る発電体の接続部分の概略図。

【図 3 8】 実施例 1 7 に係る燃料電池の構成を示す回路図。

【図 3 9】 実施例 1 7 に係る燃料電池の時間-電圧特性図。

【図 4 0】 実施例 1 8 に係る燃料電池の構成を示す回路図。

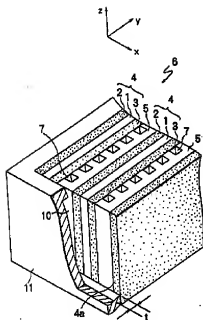
【図 4 1】 実施例 1 8 に係る燃料電池の時間-電圧特性図。

【図 4 2】 従来の燃料電池の概略図。

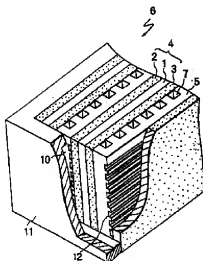
【図 4 3】 燃料電池の積層構造を示す斜視図。

【図 4 4】 本発明の燃料電池の起電部の配列構成の一例を示す構成図。

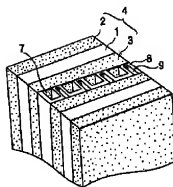
【図 1】



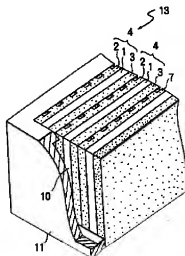
【図 3】



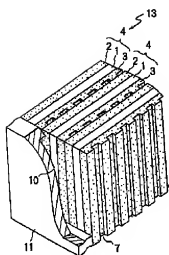
【図 2】



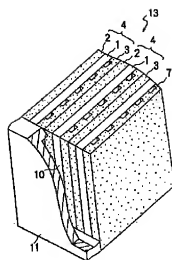
【図 4】



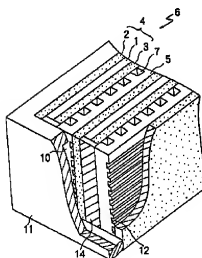
【图5】



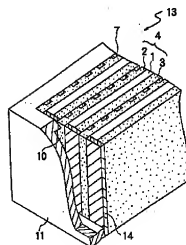
【图6】



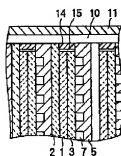
【图7】



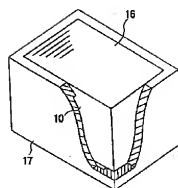
【图8】



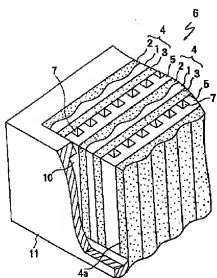
【图9】



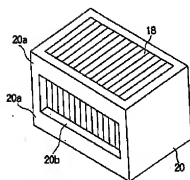
【图11】



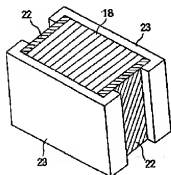
【図10】



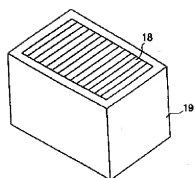
【図13】



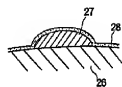
【図15】



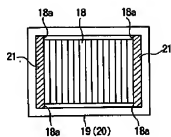
【図12】



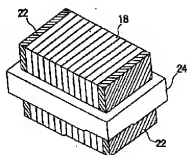
【図18】



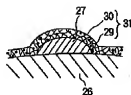
【図14】



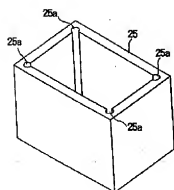
【図16】



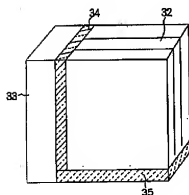
【図19】



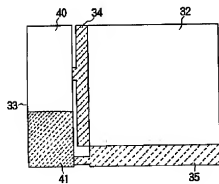
【图 17】



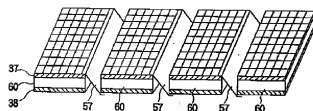
【图 21】



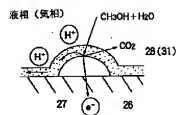
【图 23】



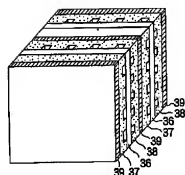
【图 33】



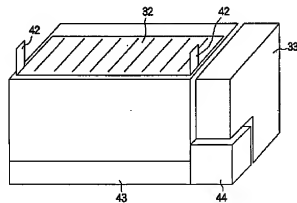
【图 20】



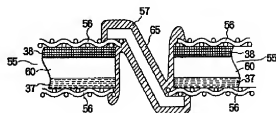
【图 22】



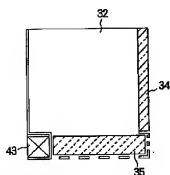
【图 24】



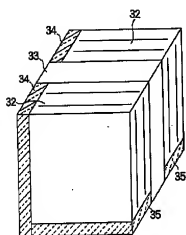
【图 36】



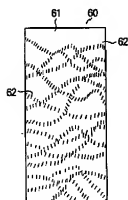
【図25】



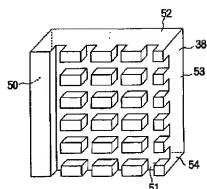
【図27】



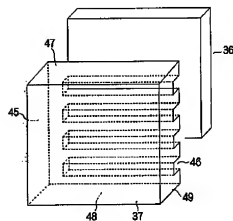
【図30】



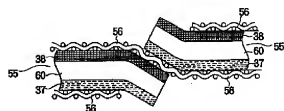
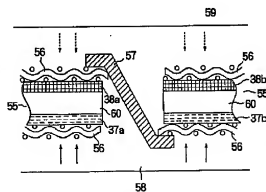
【図26】



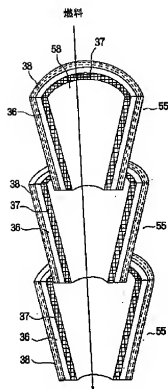
【図28】



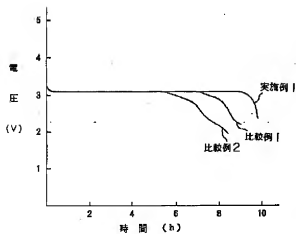
【図37】



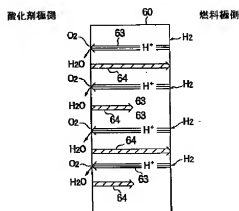
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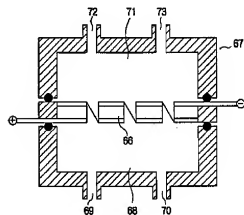
【図32】



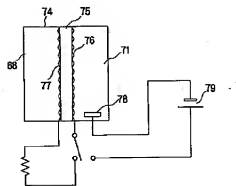
【図31】



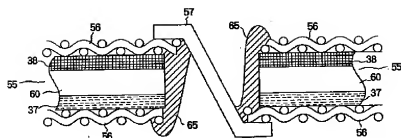
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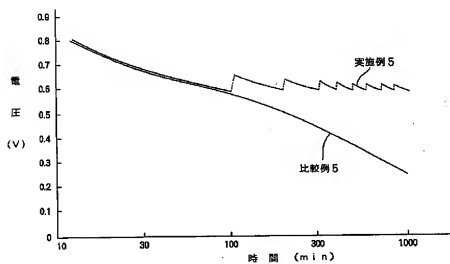
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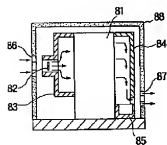
【圖34】



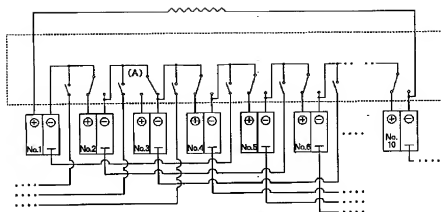
【圖39】



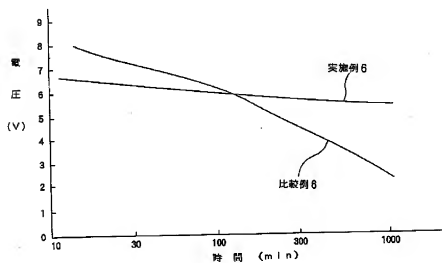
【圖42】



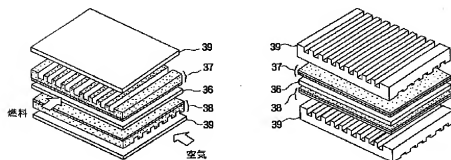
【圖40】



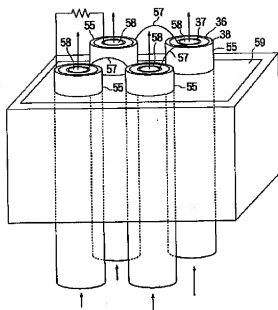
【圖41】



【圖43】



【図 4 4】



フロントページの続き

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] While providing the stack which carried out two or more laminatings of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and these two electrodes and using liquid fuel as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack At least one field arranged at the flow of said oxidant gas and parallel is met among the peripheral faces of said stack, including the end face of said fuel electrode. The fuel cell characterized by constituting in the direction which intersects perpendicularly with the flow of said oxidant gas so that the liquid fuel installation way where said liquid fuel touches directly may be established in the end face of said fuel electrode and said liquid fuel may be supplied to it by the capillary force of the porous body used as said fuel electrode at said fuel electrode.

[Claim 2] The fuel cell according to claim 1 characterized by preparing the oxidant gas supply slot which passes said oxidant gas perpendicularly to the field adjacent to said oxidizer pole of said fuel electrode.

[Claim 3] The fuel cell according to claim 1 characterized by preparing the oxidant gas supply slot which passes said oxidant gas perpendicularly to said oxidizer pole.

[Claim 4] Said liquid fuel is a fuel cell according to claim 1 characterized by being introduced from a fuel storage tank by the capillary force of said liquid fuel installation way.

[Claim 5] The fuel cell according to claim 1 characterized by forming the oxide skin in the front face of the capillary tube section which supplies said liquid fuel to said fuel electrode by capillary force.

[Claim 6] Said fuel electrode is a fuel cell according to claim 1 characterized by being constituted by the fuel oxidation catalyst particle which made the fuel oxidation catalyst exist in island shape without lapping in general mutually on the support of heat-resistant acid resistance, and made the proton conductivity matter of heat-resistant acid resistance exist in the front face of said fuel oxidation catalyst at least.

[Claim 7] While providing the stack which carried out two or more laminatings of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and two electrodes through the separator and using liquid fuel as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack The oxidant gas supply slot which passes said oxidant gas perpendicularly is established in the field adjacent to said oxidizer pole of said separator. And at least one field arranged at the flow of said oxidant gas and parallel is met among the peripheral faces of said stack, including the end face of said fuel electrode. While said liquid fuel establishes the liquid fuel installation way which touches directly in the end face of said fuel electrode and supplies said oxidant gas in the direction which intersects perpendicularly with the flow of said oxidant gas through said

oxidant gas supply slot at it The fuel cell characterized by constituting so that said liquid fuel may be supplied to this fuel electrode by the capillary force of the porous body used as said fuel electrode.

[Claim 8] The fuel cell according to claim 7 characterized by preparing the liquid fuel supply slot where opening of the end was carried out to the field which touches said fuel electrode of said separator towards said liquid fuel installation way,

[Claim 9] Said liquid fuel is a fuel cell according to claim 7 characterized by being introduced from a fuel storage tank by the capillary force of said liquid fuel installation way.

[Claim 10] The fuel cell according to claim 7 characterized by forming the oxide skin in the front face of the capillary tube section which supplies said liquid fuel to said fuel electrode by capillary force.

[Claim 11] Said fuel electrode is a fuel cell according to claim 7 characterized by being constituted by the fuel oxidation catalyst particle which made the fuel oxidation catalyst exist in island shape without lapping in general mutually on the support of heat-resistant acid resistance, and made the proton conductivity matter of heat-resistant acid resistance exist in the front face of said fuel oxidation catalyst at least.

[Claim 12] It is the fuel cell characterized by binding said stack tight at least with the ingredient which the direction of a laminating shows rubber elasticity in the fuel cell possessing the stack which carried out two or more laminatings of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and these two electrodes,

[Claim 13] The electromotive section which a fuel cell becomes from the electrolyte layer mainly pinched by a fuel electrode, an oxidizer pole, and these two electrodes, The 1st water absorption means which absorbs the water produced from the oxidizer pole in which it consisted of recovery means of the water generated on the oxidizer pole of a fuel-supply means to supply a fuel to said electromotive section, and said electromotive section, and got down, and said water recovery means was formed in contact with the oxidizer pole, It is the fuel cell with which the 1st water absorption means established in contact with said 1st water absorption means consists of the 2nd water absorption means which absorbs the water which carries out absorption maintenance, and said 2nd water absorption means is characterized by being set up so that water absorbance may serve as size rather than said 1st water absorption means.

[Claim 14] the electromotive section which consists of an electrolyte layer pinched by a small fuel cell, a fuel electrode, an oxidizer pole, and these two electrodes -- two or more -- connection -- the fuel cell characterized by to have the structure where a conductor connects with a serial, and a fuel is supplied from a fuel path common to the fuel electrode of each electromotive section, and the electrode surface of the fuel electrode of each generation-of-electrical-energy section faces said fuel path, and for said electrolyte layer to contain the absorptivity matter or the water retention matter.

[Claim 15] It is the fuel cell characterized by having the device to which said fuel cell carries out polarization of the fuel electrode anodically in the fuel cell which consists of an electrolyte layer pinched by a fuel electrode, an oxidizer pole, and these two electrodes.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to a fuel cell, especially the fuel cell suitable for a miniaturization.

[0002]

[Description of the Prior Art] Since a fuel cell is efficient as an independent power plant, it attracts attention recently. A fuel cell is divided roughly into the phosphoric acid fuel cell which uses gas as a fuel, a fused carbonate fuel cell, a solid oxide fuel cell, an alkaline electrolytic-solution mold fuel cell, etc. a methanol fuel cell, a hydrazine fuel cell that use a liquid as a fuel, etc. Since these fuel cells are aimed at the source of power for mainly moving the generator for power, and a large-sized device, a compressor, a pump, etc. for introducing the fuel of gas or a liquid or oxidant gas in a cell are required for them, and it is not only complicated as a system, but they consume power for these installation.

[0003] If the methanol fuel cell using the methanol as liquid fuel is explained as an example, in the system of a methanol fuel cell, a fuel will be sent to a cell proper with a pump from a methanol tank, and the air which is an oxidizing agent will be sent to a cell proper by the blower. For example, in order [which is the methanol and electrolyte which especially serve as a fuel as dissolution fuels by this cell] to feed a mixed liquor object with a dilute sulfuric acid to a cell proper with a pump through a methanol controller or an acid controller, that system is much more complicated. Such complexity is the same about other fuel cells, and a blower and a pump are needed in order to send a fuel and oxidizing agent gas by any system. The complexity of such a system is because the present fuel cell is targetting mass power as the object for power, a source of power of a large-sized device, etc., in order to attain this, a lot of fuels and oxidizing agent gas must be passed, and therefore, a pump, a blower, etc. are needed.

[0004] On the other hand, as a social trend, various devices, such as OA equipment, audio equipment, and a wireless device, are miniaturized with development of semiconductor technology, and portable nature is demanded further. As a source of a generation of electrical energy for satisfying such a demand, an easy primary cell, an easy rechargeable battery, etc. are used. However, a primary cell and a rechargeable battery have a limit in a function top time, and, naturally a time is limited in the OA equipment using such a cell. When these cells are used, after discharge of a cell finishes, a time is [as opposed to / with the primary cell of what can exchange cells and can move OA equipment etc. / the weight] short, and it is unsuitable for a portable device. Moreover, if discharge finishes with a rechargeable battery, while it can charge, there is a fault a service space is not only restricted, but that a power source is required because of charge, and charge takes time amount. Since it is difficult to exchange cells even if discharge of a cell finishes it especially as the OA equipment incorporating a rechargeable battery, as for a limit of

the time of a device, **** does not have **. Thus, in order to carry out long duration actuation of the various small devices, correspondence is difficult and extension of the conventional primary cell and a rechargeable battery requires the cell which was more fit for actuation of long duration.

[0005] There is a fuel cell which was mentioned above as one solution of such a problem. Since it has the advantage it not only has the advantage that it can generate electricity only by supplying a fuel and an oxidizer, but that it can generate electricity continuously if fuels are exchanged, a fuel cell can be called system very advantageous to actuation of small devices, such as OA equipment with small power consumption, if a miniaturization is possible.

[0006] Since air can be used for a fuel cell as an oxidizer, a limit is received from a viewpoint of an oxidizer neither in a service space nor a time, but although power consumption, such as OA equipment, is small when using gas as a fuel, considering the consistency of gas, the capacity which a generation of electrical energy takes is large, and unsuitable for the miniaturization of a cell. On the other hand, compared with gas, the consistency of liquid fuel is high, and it is overwhelmingly advantageous as a fuel of the fuel cell for small devices. Therefore, if the fuel cell using liquid fuel can be miniaturized, the power source for small equipments in which the long duration actuation which is not in the former is possible is realizable. As mentioned above, in order to send liquid fuel into a cell proper, in the system using the conventional liquid fuel, that a pump is complicated as a system and is miniaturized with the structure of this as since the blower etc. is required in order to send in oxidizing agent gas again has a failure when realizing such a power source for small equipments in a difficult thing.

[0007] Furthermore, the gas supplied to the cell by the pump or the blower in a phosphoric acid fuel cell, a fused carbonate fuel cell, and the conventional fuel cells, such as a solid oxide fuel cell, is further introduced into each electrode through the gas channel which adjoined the oxidizing agent pole and the fuel electrode and was prepared. In this case, from a viewpoint of passing a lot of fuel gas and oxidizing agent gas so that a load may be given to neither a pump nor a blower, the gas passageway of a gas channel is made into the shape of a big quirk so that a pressure loss may not arise as much as possible. For example, at the gas channel of a fused carbonate fuel cell, it is usual. The slot of the depth which exceeds 2mm is formed. Also with the fuel cell using liquid fuel like a methanol fuel cell, this is the same, differs in the phosphoric acid fuel cell mentioned [especially] above by the methanol fuel cell, and serves as a still bigger value than the case where gas is used as a fuel about a pressure loss at them in order to pass a mixture with the methanol which is an electrolyte and which becomes a sulfuric acid and a fuel, for example to an electrolyte layer and a fuel electrode. in order that [thus,] the conventional fuel cell may send in gas and a liquid by the pump or the blower -- the shape of a quirk of a gas channel -- large -- not carrying out -- it does not obtain, but when the shape of a quirk is conversely made small, in extension of an old technique -- a pump and a blower become large -- a miniaturization has the problem that it cannot attain.

[0008] A point which was mentioned above is coped with and the liquid fuel cell (refer to JP,59-66066,A) which used capillary force for supply of liquid fuel is proposed as a fuel cell which aimed at correspondence to a miniaturization. This liquid fuel cell is a cell of the parallel flow method which sucks up to an one direction toward the upper part from the fuel stockroom which prepared liquid fuel in the lower part, and supplies an anode, and passes oxidant gas in the same direction as the supply direction of a fuel by the capillary force of the capillary tube ingredient which used synthetic fibers, such as organic [, such as paper, cotton, asbestos, and glass,] or an inorganic fiber ingredient, and an acrylic, nylon, as the base material. By this cell, while

establishing a fuel stockroom in the lower part, in order to pass oxidant gas perpendicularly, the intake of gas is required for the lower part of a cell, therefore it has structure which prepared the clearance between the fuel stockroom and the stack base. Moreover, that component consists of fiber which has flexibility which was mentioned above so that some capillary tube ingredients may be narrowed down mechanically and supply of a fuel can be controlled by this method. Furthermore, this cell has structure embedded so that a capillary tube ingredient which was mentioned above, and which was electrically constituted from an insulating ingredient might stick with a charge collector to some anode side charge collectors.

[0009] Although the above-mentioned liquid fuel cell fits a miniaturization rather than the conventional fuel cell in order to supply liquid fuel to a fuel electrode by capillary force, two or more problems are included and those improvements are called for. For example, although liquid fuel penetrates or permeates horizontally in an anode (fuel electrode) as indicated by the above-mentioned official report, in the direction of facing up, it has the constraint on the structure where capillarity is not shown. Moreover, by the cell of this method, as mentioned above, since it is the structure where a clearance inserts a fibrous capillary tube ingredient required between a stack base and a fuel stockroom at a fuel stores dept., while the seal of a capillary tube ingredient and a fuel stockroom becomes difficult, it must be made the structure which unifies a stack and a fuel stockroom and is fixed. And structure not only becomes complicated, but it must prepare two or more entries for introducing a capillary tube ingredient into the fuel stockroom upper part on the occasion of unification, and the manufacture has the fault of being very difficult. If it furthermore says, in order to pour an oxidizer, in this fixed structure, it complicates structure that it is also necessary to open a slit in a part for the oxidizer polar zone at the base of a stack at least.

[0010] Moreover, since liquid fuel is supplied to the upper part by the capillarity of an one direction from the lower part as mentioned above, it will require time amount for a fuel being supplied to the upper part of a fuel electrode upwards, and will receive constraint in the configuration of a cell. That is, in order to enlarge a current, it is necessary to enlarge area of electromotive components, such as an electrode and an electrolyte plate, but, and when a limit exists in height like this method, the width of face of electromotive components is come size, and a kink colander is not obtained, but constraint arises in a cell configuration. Furthermore, by this cell, since the insulating capillary tube ingredient is embedded at the part in the charge collector by the side of a fuel electrode, the electron obtained as a result of the cell reaction has the fault of not obtain a flow colander, but the path for which the electrical and electric equipment not only concentrates, but the electrical and electric equipment flows become long about a charge collector, and produce an electric loss.

[0011] On the other hand, in order to improve contact between cell components with the conventional high power and the fuel cell of a large area about bolting of a cell and to aim at improvement in the engine performance, the large-sized clamping device with which the force joins homogeneity was used. For example, the cell area of a commercial phosphoric acid fuel cell or a fused carbonate fuel cell is 2 5000-10000cm about. In order to bind this tight so that contact between components may become good, it is 15 - 30ton in general. It must bind tight with the equipment which has a bolting load. Therefore, each clamping device used for the conventional fuel cell is complicated and large-scale equipment, and does not fit the fuel cell which is going to attain a miniaturization.

[0012] There is a problem of removal of the water which, on the other hand, generates the system of the conventional fuel cell as a resultant in an electrode surface as one of the factors to

complicate. Although it is one electrode in a fuel cell and water arises as a product of electrode reaction, it is necessary to remove this water from an electrode surface. Piling up in the electrode surface which is a product bars supply of the matter which should be supplied, and it reduces reaction effectiveness as a result.

[0013] Although it is expectable as a power source for small devices since especially the solid-state polyelectrolyte mold fuel cell using proton conductivity film, such as perfluorocarbon sulfonic acid (trade name: product made from Nafion:Du Pont), as an electrolyte operates at low temperature (room temperature -100 degree C) comparatively In the fuel cell which operates at such low temperature 100 degrees C or less, since the water produced on the oxidizer pole generates in the state of a liquid, the problem of stagnation of the water in an electrode surface will become much more serious that it is hard to vaporize.

[0014] In the conventional fuel cell, prepared the air supply duct in the side face of a cell proper, have arranged the air jet pipe to that opposite side, generation water was made to dew the wall surface of this air jet pipe, and generation water was collected. The schematic diagram of the conventional fuel cell is shown in drawing 42.

[0015] That is, as shown in drawing 42, the air discharge duct 84 is installed in the air supply duct 83 which attached the blower 82 in the side face of the body 81 of a fuel cell, and its opposite side, the generation water recovery duct 54 is formed in the bottom of this air discharge duct 84, and it contains in the cell case 57 in which the air entry 86 and the air outlet 87 opened these. Supply of air is performed by the blower 82, the air containing generation water is sent in the air discharge duct 84, the generation water which generation water dewed the internal surface of this air discharge duct 84, and dewed it is collected by the lower generation water recovery tank 85, and discharge air is discharged outside through an air outlet 87.

[0016] If the above recovery approaches of generation water are applied to a small fuel cell which is expected, it becomes impossible to disregard the volume of the drive power of the blower itself, or a blower, and the advantages, such as high charging efficiency and a small thing, will be lost. Although the recovery approach of generation water is otherwise proposed, it is necessary to supply the energy equivalent to heat of vaporization, and energy efficiency does not become good theoretically by the approach of making generation water once evaporating.

[0017] Therefore, the device in which the water generated from an oxidizer pole is removed is needed, without using special power and energy, in order to realize a small fuel cell.

[0018] On the other hand, there is a problem on the structure as another factor which complicates the system of a fuel cell.

[0019] The general laminated structure is shown by making a phosphoric acid fuel cell into an example at drawing 43. In this case, the electric conduction plate 39 called a separator or interconnector between the electromotive sections which consist of the oxidizer pole 38, an electrolyte layer 36, and a fuel electrode 37 was placed, by this, each electromotive section was connected to the serial and the required electrical potential difference is secured. This structure is applied to the solid-state polyelectrolyte mold fuel cell etc. not only at a phosphoric acid fuel cell but at a fused carbonate fuel cell and a pan. In the fuel cell of such structure, the air as the fuel supplied to the cell using the pump, the blower, etc. or an oxidizer is introduced into each electrode through the separator which adjoined the oxidizer plate and the fuel electrode plate and was formed. In this case, the gas passageway of a separator or an electrode plate is made into the shape of a quirk which has a certain amount of depth so that a pressure loss may not arise as much as possible from a viewpoint of pouring a lot of fuels and reacting matter, such as oxidizing agent gas, so that a load may be given to neither a pump nor a blower. When especially

liquid fuel, such as a methanol, is used, in order to pour a liquid-like fuel unlike the phosphoric acid fuel cell mentioned above, about a pressure loss, it becomes a still bigger value than the case where gas is used as a fuel.

[0020] Thus, since it is necessary to form a slot etc. in a separator etc. as passage of this reacting matter, the fuel cell of the conventional structure cannot but take a certain amount of thickness, and the volume occupied other than the reaction catalyst of the electrolyte layer which is the original generation-of-electrical-energy section, a fuel, and an oxidizer pole, and a charge collector must be enlarged. Even if it makes small thinly the electrode plate thru/or separator which acts as passage, in order to supply reacting matter through passage narrow in this case, a burden must be placed on a pump, a blower, etc., and those devices must be enlarged.

[0021] The volume occupied other than the reaction catalyst of the electrolyte layer which be the original electromotive section, a fuel electrode, and an oxidizer pole, and a charge collector from such a thing be stopped as small as possible, two or more electromotive sections be arranged in horizontal ***** at right angles to the thickness direction as a policy which attain the miniaturization of the whole fuel cell, and how to connect so that it may become a serial mutually at the edge can be considered. In this case, since it can perform supply of reacting matter, and recovery of a product from one space and it is not necessary to two or more electromotive sections a separator not only to become unnecessary, but to give the function as passage to an electrode plate, there is no abbreviation and it can be made thin. Such a view is already indicated by JP,63-141266.A, JP,63-141270.A, etc.

[0022] However, a problem as shown below arises in the fuel cell of such a configuration.

[0023] The object contained in an electrolyte layer, and an electrolyte and a steam of the same kind are mixed in the reacting matter supplied in order to compensate an outflow and evaporation of the component in the electrolyte from an electrolyte layer with the usual fuel cell or to prevent desiccation.

[0024] Especially, since water flows from a fuel electrode with ion to an oxidizer pole at the time of operation, the solid-state polyelectrolyte mold fuel cell using proton conductivity film, such as the above-mentioned perfluorocarbon sulfonic acid (trade name: product made from Nafion Du Pont), etc. as an electrolyte runs short of the moisture by the side of a fuel electrode gradually, and effectiveness falls. Therefore, into the fuel supplied to a fuel electrode, in the case of liquids, such as a methanol, mixed the electrolyte of a liquid, the case of hydrogen gas made the steam mix, and it supplied.

[0025] On the other hand, generation of water takes place in the electrode of another side. In the above-mentioned polymer electrolyte fuel cell, in an oxidizer pole side, since the water which flows from a fuel electrode besides the water generated according to electrode reaction exists, moisture becomes superfluous.

[0026] The water which mixed in such reacting matter and was supplied, and an electrolyte or the generated water combines and short-circuits between two or more generation-of-electrical-energy components in ion, and becomes the cause which causes the fall of cell voltage. The problem is remarkable if the above-mentioned water and an electrolyte exist in the state of a liquid especially.

[0027] Like the above-mentioned, two or more generation-of-electrical-energy components are put in order lining up side-by-side, the fuel cell of a configuration of having connected the edge to the serial shares the supply space of a fuel, and the recovery space of a product, and since an inter-electrode distance is short, the problem of such an electrical-potential-difference loss is much more serious.

[0028] The schematic diagram at the time of arranging the two generation-of-electrical-energy sections in drawing 28 lining up side-by-side, and connecting with it at a serial is shown. As for a fuel electrode and 60, in drawing 28, 37 is [an electrolyte layer and 38] oxidizer poles, and the two electromotive sections 55 are electrically connected to the serial by lead 57. The fuel electrodes 37a and 37b and oxidizer pole comrade of the two generation-of-electrical-energy sections adjoin each other. Both the generations-of-electrical-energy section can perform supply of a fuel, and discharge of a product from one space. In drawing 28, supply of a fuel is performing supply of oxidant gas from the fuel passage 58 in the oxidizer passage 59.

[0029] In this case, the electric potential gradient has arisen between fuel electrode 37a of the one generation-of-electrical-energy section, oxidizer pole 38a of this generation-of-electrical-energy section, and fuel electrode 37b of same electric potential. Moreover, the inclination of potential has arisen similarly between oxidizer pole 38a and oxidizer pole 38b.

[0030] If the matter which acts as an electrolyte exists in both the electromotive section front face 58, i.e., fuel passage, and the oxidizer passage 39 at this time, migration of ion will take place according to the above-mentioned electric potential gradient, this acts as the leakage current, and an electrical-potential-difference loss arises.

[0031] Therefore, two or more generation-of-electrical-energy sections are lined up side-by-side like the above, and it connects with a serial, and in attaining the miniaturization of a fuel cell according to the structure which makes common fuel-supply space and recovery space of a product, in order for the effectiveness of a cell to fall by the electrical-potential-difference loss produced between each generation-of-electrical-energy section, it is necessary to reduce such an electrical-potential-difference loss.

[0032] As a fuel generally supplied to a fuel cell on the other hand, there are gases, such as hydrogen gas, or liquids, such as a methanol and a hydrazine. Although power consumption, such as OA equipment, is small when using gas as a fuel, considering the consistency of gas, the capacity which a generation of electrical energy takes is large, and unsuitable for the miniaturization of a cell. On the other hand, compared with gas, the consistency of liquid fuel is high, and it is overwhelmingly advantageous as a fuel of the fuel cell for small devices. Therefore, if the fuel cell using liquid fuel can be miniaturized, the power source for small equipments in which the long duration actuation which is not in the former is possible is realizable.

[0033] Since C1 - C2 compounds, such as a methanol and ethanol, are cheap and the boiling point is also moderately high also in liquid fuel, it can use easily from a safety aspect. However, there is development of an electrode catalyst as a technical difficulty in such a cell. That is, in the anodic oxidation of the fuel containing carbon like a methanol, the high platinum of catalytic activity also serves as a practically serious trouble in order for poisoning by which the intermediate product of a reaction sticks to an electrode surface firmly with the passage of time to appear and to bring about the fall of large catalyst ability.

[0034] Although the electrode catalyst excellent in poisoning-proof nature is examined, it has come [therefore,] to acquire still sufficient property. Therefore, for the moment, long duration and the fuel cell with which it is stabilized and high power is obtained are not obtained. Therefore, in the case of the fuel cell using organic fuels, such as a methanol, it is necessary to control poisoning of an electrode surface.

[0035] As mentioned above, the fuel cell of a common conventional type has a complicated system, and the miniaturization has the problem of being difficult, with the configuration as it is. A miniaturization which is suitable for the power source for small devices etc. on the other hand

since structure is complicated and the constraint on structure also has it, although the conventional liquid fuel cell using capillary force fits a miniaturization constitutionally is not attained. [much] Moreover, the correspondence to the miniaturization of a fuel cell is called for also about an approach to bind cell components tight, discharge of the generated water, and connection between the electromotive sections. When liquid fuel is furthermore used, correspondence is called for also about poisoning of an electrode surface.

[0036]

[Problem(s) to be Solved by the Invention] This invention solved the above-mentioned technical problem in the above-mentioned conventional fuel cell, it was carried out in order to offer a small fuel cell useful as a power source of a small device, and it is in offering the fuel cell which made it possible to miniaturize after maintaining a well head by simplifying structure while simplifying the distribution system of the 1st liquid fuel and oxidant gas of the purpose of this invention.

[0037] It is in offering the fuel cell which performed discharge of the water generated with actuation of the purpose of the 2nd fuel cell, without using special power and energy, and was suitable for the miniaturization. Furthermore, the 3rd of the purpose suppresses the ionic conduction between the electromotive sections to the minimum, and even if it makes connection between the electromotive sections suitable for the miniaturization of a fuel cell, offering the fuel cell which was suitable for practical use enough few has an electrical-potential-difference loss. Furthermore, when liquid organic fuels, such as a methanol which was suitable as a fuel used for a small fuel cell, are used, the 4th of the purpose stops poisoning produced in an electrode surface, and is to offer the fuel cell with which the output stabilized for a long time is obtained.

[0038]

[Means for Solving the Problem and its Function] The 1st fuel cell which it was carried out in order that this invention might attain the above-mentioned purpose, and is made simplification of the feeding system which is the 1st of the purpose While providing the stack which carried out two or more laminations of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and these two electrodes and using liquid fuel as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack it has been arranged among the peripheral faces of said stack at the flow of said oxidant gas, and parallel, including the end face of said fuel electrode -- at least -- One field is met. It is characterized by constituting so that the liquid fuel installation way where said liquid fuel touches directly may be established in the end face of said fuel electrode and this liquid fuel may be supplied in the direction which intersects perpendicularly with the flow of said oxidant gas by capillary force at said fuel electrode.

[0039] While the 2nd fuel cell possesses the stack which carried out two or more laminations of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and two electrodes through the separator and liquid fuel is used for it as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack The oxidant gas supply slot which passes said oxidant gas perpendicularly is established in the field adjacent to said oxidizer pole of said separator, and it has been arranged among the peripheral faces of said stack at the flow of said oxidant gas, and parallel, including the end face of said fuel electrode -- at least -- One field is met. While said liquid fuel establishes the liquid fuel installation way which touches directly in the end face of said fuel electrode and supplies said oxidant gas in the direction which intersects perpendicularly with the flow of said oxidant gas through said oxidant gas supply slot at it It is characterized by constituting so that

said liquid fuel may be supplied to this fuel electrode by the capillary force of the porous body used as said fuel electrode.

[0040] Furthermore, while the 3rd fuel cell possesses the stack which carried out two or more laminations of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and two electrodes through the separator and liquid fuel is used for it as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack The oxidant gas supply slot which passes said oxidant gas perpendicularly is established in the field adjacent to said oxidizer pole of said separator, and it has been arranged among the peripheral faces of said stack at the flow of said oxidant gas, and parallel, including the end face of said fuel electrode -- at least -- While preparing a liquid fuel installation way in the direction which intersects perpendicularly with the flow of said oxidant gas along one field While an end establishes the liquid fuel supply slot by which opening was carried out in the field which touches said fuel electrode of said separator and supplies said oxidant gas to it through said oxidant gas supply slot towards said liquid fuel installation way It is characterized by constituting said liquid fuel from capillary force of said liquid fuel supply slot at least, so that this fuel electrode may be supplied.

[0041] Furthermore, while the 4th fuel cell possesses the stack which carried out two or more laminations of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and these two electrodes and liquid fuel is used for it as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack The oxidant gas supply slot which passes said oxidant gas perpendicularly is established in the field adjacent to said oxidizer pole of said fuel electrode, and it has been arranged among the peripheral faces of said stack at the flow of said oxidant gas, and parallel, including the end face of said fuel electrode -- at least -- One field is met. While said liquid fuel establishes the liquid fuel installation way which touches directly in the end face of said fuel electrode and supplies said oxidant gas in the direction which intersects perpendicularly with the flow of said oxidant gas through said oxidant gas supply slot at it It is characterized by constituting so that said liquid fuel may be supplied to this fuel electrode by the capillary force of the porous body used as said fuel electrode.

[0042] Furthermore, while the 5th fuel cell possesses the stack which carried out two or more laminations of the electromotive section which has the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and these two electrodes and liquid fuel is used for it as a fuel In the fuel cell constituted so that oxidant gas might be perpendicularly passed along the laminating side of said stack The oxidant gas supply slot which passes said oxidant gas perpendicularly is established in said oxidizer pole, and it has been arranged among the peripheral faces of said stack at the flow of said oxidant gas, and parallel, including the end face of said fuel electrode -- at least -- One field is met. While said liquid fuel establishes the liquid fuel installation way which touches directly in the end face of said fuel electrode and supplies said oxidant gas in the direction which intersects perpendicularly with the flow of said oxidant gas through said oxidant gas supply slot at it It is characterized by constituting so that said liquid fuel may be supplied to this fuel electrode by the capillary force of the porous body used as said fuel electrode.

[0043] Furthermore, in the fuel cell possessing the stack which carried out two or more laminations of the electromotive section which has the electrolyte plate with which the 6th fuel cell was pinched by a fuel electrode, an oxidizer pole, and these two electrodes, said stack is characterized by being bound tight with the ingredient which the direction of a laminating shows rubber elasticity at least.

[0044] In the above fuel cell of this invention, since it constitutes so that oxidant gas may be first passed perpendicularly to a stack, oxidant gas can be passed effectively. Moreover, a liquid fuel installation way is prepared in the direction which intersects perpendicularly with the flow of oxidant gas along with the stack peripheral face arranged at the flow of oxidant gas, and parallel, and the positive supply by the capillary force of liquid fuel is attained, without checking the flow of oxidant gas, since it constitutes so that the liquid fuel introduced in this liquid fuel installation way may be supplied to a fuel electrode by capillary force. Moreover, while being able to simplify structure, there is also little constraint on a configuration. Without using especially auxiliary parts, such as a pump and a blower, oxidant gas and liquid fuel can be supplied smoothly, and these enable it to attain a miniaturization therefore.

[0045] The fuel cell with which the discharge approach of the generation water which is the 2nd purpose of this application has been improved has the following configuration.

[0046] namely, a fuel electrode and an oxidizer pole -- and the generation-of-electrical-energy section which has the electrolyte layer pinched by these two electrodes, the 1st porous body which absorb the water which it is prepared in contact with an oxidizer pole, and produces from an oxidizer pole, and the 2nd porous body which absorb the water which it is prepared in contact with the 1st porous body, and the 1st porous body holds are the fuel cells characterized by to be constituted so that an average pole diameter may become small along the direction where water flows.

[0047] For example, in the fuel cell using liquid fuel, such as a methanol, it operates as a fuel cell by the device shown below.

[0048] Fuels, such as a methanol, are supplied to a fuel electrode and oxygen is supplied to an oxidizer pole. When a methanol is made into an example, the following reactions occur.

[0049] fuel electrode (anode): -- $\text{CH}_3\text{OH} + \text{H}_2\text{O} \rightarrow \text{CO}_2 + 6\text{H}^+ + 6\text{e}^-$ oxidizer pole (cathode): $\frac{3}{2}\text{O}_2 + 6\text{H}^+ + 6\text{e}^- \rightarrow 3\text{H}_2\text{O}$ overall reaction: -- $\text{CH}_3\text{OH} + \frac{3}{2}\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ -- that is In a fuel electrode, a methanol carries out an equimolar reaction with water, carbon dioxide gas and a proton are produced, and a proton reacts with oxygen with a fuel electrode through the solid-state polyelectrolyte film, and generates three-mol water. In total, a methanol and oxygen react and two-mol water is generated. It is necessary to remove the water generated at least to make such a reaction perform smoothly you to be Sumiya.

[0050] Moreover, when the power source for small devices is assumed, it is necessary to perform this without special power.

[0051] Therefore, the structure of the oxidizer pole in the invention in this application prepares a porous body so that an oxidizer pole front face may be touched, or it uses the oxidizer pole itself as a porous body, and absorbs the water produced to the oxidizer pole in the operation of the capillarity of a porous body. A porous body with the capillary tube force stronger than the oxidizer pole itself which consists of the porous body or porous body prepared so that recovery of water might furthermore touch an oxidizer pole front face, i.e., a porous body with an average pole diameter smaller than said porous body, is contacted to the oxidizer which consists of the porous body or porous body prepared so that an oxidizer pole front face might be touched. Thereby, water is smoothly removed from an oxidizer pole front face.

[0052] Especially this invention is effective if the water generated on the oxidizer pole applies to the fuel cell which operates at the temperature which is a liquid, i.e., the temperature of about 100 degrees C or less. That is, the water absorption by the capillarity of a porous body is for acting effectively, when water is a liquid.

[0053] As fuel cell about 100 degrees C or less, there are alkaline fuel cells and the phosphoric

acid fuel cell under a special service condition, a solid-state polyelectrolyte mold fuel cell, etc. [operating temperature] It is suitable, when especially the solid-state polyelectrolyte used for a solid-state polyelectrolyte mold fuel cell consists of a high molecular compound which has ion-exchange ability, what formed this in the shape of film does not have the spill of the electrolytic solution, and mixing of the reacting matter of an anode and a cathode is prevented, and a fuel cell system is miniaturized and it is simplified. Although the solid-state poly membrane of proton conductivity has put in practical use in the present condition, an anion conducting film may be used.

[0054] Moreover, when the miniaturization of a fuel cell is taken into consideration, as a fuel, use of hydrogen gas etc. is possible. For example, the hydrogen gas by which occlusion was carried out to the hydrogen storing metal alloy may be used. However, it is desirable practically to use a fuel like alcohols like the methanol which is a liquid, and ethanol, a hydrazine, or an amine acid in ordinary temperature.

[0055] The fuel cell with few electrical-potential-difference losses between the electromotive sections which are the 3rd of the purpose of this application has the following configurations. Namely, it has the electromotive section which has the electrolyte layer pinched by a fuel electrode, oxidizer poles, and these electrodes. Two or more electromotive sections are connected to a serial, and a fuel is supplied from the fuel passage where the fuel electrode of each electromotive section is common. And the electrode surface of the fuel electrode of each electromotive section faces said fuel passage, or an oxidizer is supplied from the oxidizer passage where the oxidizer pole of each electromotive section is common. And in the fuel cell of the structure where the electrode surface of the oxidizer pole of each electromotive section faces said oxidizer passage, it is characterized by the aforementioned electrolyte layer containing absorptivity or a water retention object.

[0056] That is, in the above fuel cell, the thing which made the absorptivity which moisture is supplied and held inside [other than the compound which has the ion-exchange capacity which is the main constituent of the usual electrolyte as an electrolyte layer of the electromotive section] the film, or can pass moisture according to a concentration gradient, or the water retention matter coexist is used.

[0057] While maintaining the electrolyte layer which starts this invention as mentioned above at the condition that the water generated on one electrode catalyst front face is absorbed promptly, and the active substance can always be contacted in a catalyst front face in order to show absorptivity thru/or water retention oneself, the absorbed water diffuses the inside of an electrolyte according to a concentration gradient, and the work which prevents desiccation of the electrode surface of another side also shows it. The outstanding property in which the electrolyte itself can furthermore maintain ionic dissociation effective have [no addition of the moisture from the outside] always and an ionic conduction property in this process is shown.

[0058] Therefore, in the fuel layer using this electrolyte layer, since the water which could supply water into the electrolyte, without making water mix into the reacting matter to supply, and was produced on the oxidizer pole is absorbed by whether you are Sumiya, it can suppress ionic conduction other than an electrolyte layer small.

[0059] As the absorptivity concerning this invention, or water retention matter, gel compounds, such as water absorbing polymer compounds, such as starch, an acrylonitrile copolymer, bridge formation acrylate, and bridge formation polyethylene oxide, a silica hydrogel, and conversion protein (gelatin), etc. can be used.

[0060] Moreover, in the case of a solid-state polyelectrolyte, as an electrolyte, the remarkable

effectiveness of the invention in this application is acquired. As a solid-state polyelectrolyte, it is a perfluorocarbon-sulfonic-acid polymer (trade name: the cation exchange membrane of the polystyrene system which has a Nafion (U.S. Du Pont shrine make) sulfonic group is mentioned.) as a proton conductivity solid-state polyelectrolyte.

[0061] By using such the electromotive section, the fuel cell which is the configuration of more than an unescapable mixing grain having not contained the matter which acts as an electrolyte into any [of the reacting matter supplied to the oxidizer pole and fuel electrode which are the main point of this invention], and having connected the edge of two or more electromotive sections to the serial mutually is realizable.

[0062] Next, in order to prevent the approach, and mixing and the leakage current of reacting matter which carry out direct continuation of the charge collector of each generation-of-electrical-energy component with welding, electroconductive glue, etc. as an approach of connecting mutually the edge of two or more generation-of-electrical-energy components to a serial, in case the approach of connecting through an electric conduction plate etc. or the generation-of-electrical-energy section is produced, the approach of making unify so that series connection may be carried out beforehand, and producing two or more generation-of-electrical-energy sections etc. can be adopted.

[0063] Furthermore, in order to suppress the leakage of an electrolyte in these approaches, it is also effective to give the connection part of two or more electromotive sections a water-repellent finish.

[0064] Next, the fuel cell for stopping poisoning produced in the electrode surface which is the 4th of the purpose of this application is characterized by having the device to which polarization of the fuel electrode is carried out anodically in the fuel cell equipped with the electrolyte layer pinched by a fuel electrode, an oxidizer pole, and these two electrodes.

[0065] That is, in this invention, when the poisoning product on the front face of a fuel electrode arises at the time of operation of a fuel cell, a counter electrode is connected to a fuel electrode, polarization is carried out anodically, and oxidation removal of said poisoning product is carried out. The fuel cell with which the output which carried out long duration stability is obtained by that cause is obtained.

[0066] In the fuel cell, two or more electromotive sections which consist of a fuel electrode, an oxidizer pole, and an electrolyte are further usually connected and used for the serial. In this case, it is desirable to perform said polarization actuation as rotation for every electromotive section. A poisoning product can be removed without this interrupting operation.

[0067]

[Example] Hereafter, the embodiment of this invention is explained. First, the fuel cell miniaturized by the simplification of the distribution system of the liquid fuel and oxidant gas which are the 1st of the purpose of this application, and the simplification of structure after carrying out efficient maintenance is explained.

[0068] drawing 1 shows the important section configuration of the fuel cell of one example -- it is a notching perspective view a part. In this drawing, 1 is the electrolyte plate pinched by the fuel electrode (anode) 2 and the oxidizer pole (cathode) 3, and the electromotive section 4 is constituted by these electrolyte plates 1, the fuel electrode 2, and the oxidizer pole 3. Here, a fuel electrode 2 and the oxidizer pole 3 are formed by the conductive porous body so that it may let an electron pass, while they circulate a fuel and oxidant gas.

[0069] And the stack 6 used as a cell proper is constituted by carrying out two or more laminatings of the electromotive section 4 which was described above through a separator 5.

This stack 6 is installed so that the laminating side of the electromotive section 4 may become parallel to a perpendicular direction fundamentally. In addition, the above-mentioned separator 5 is formed with a conductive ingredient in order to also achieve the function of the collecting electrode plate which conducts the generated electron. Although the catalyst bed of stratified, island shape, or granular ** may furthermore be formed between a fuel electrode 2, the oxidizer pole 3, and an electrolyte plate 1 if needed, this invention does not receive constraint in the existence of such a catalyst bed. Moreover, it is good also considering fuel electrode 2 and oxidizer pole 3 the very thing as a catalyst electrode.

[0070] Here, in the fuel cell of this invention, in order to pass oxidant gas, for example, air, effectively, without needing power, it is necessary to consider as the structure where oxidant gas flows perpendicularly to a stack 6. Oxidant gas will flow very smoothly with the heat generated as a result of producing a cell reaction by passing oxidant gas toward the upper part especially from the lower part of a stack 6. So, in this example, the oxidant gas supply slot 7 which passes oxidant gas perpendicularly (the inside of drawing, the direction of z) is established in the field adjacent to the oxidizer pole 3 of a separator 5 as a continuation slot.

[0071] Moreover, since [remarkable] it is small compared with a liquid, if the balance of liquid fuel required for a cell reaction and oxidizing agent gas is considered, as for the consistency of gas, it is more advantageous than supply of liquid fuel to make it the structure which increases supply of oxidant gas because of the miniaturization of effectiveness, the engine performance, as a result a cell. Although it becomes so advantageous that the cross section of the oxidant gas supply slot 7 is enlarged, if an electric touch area will become small, a loss will arise, if a flute width is enlarged too much in order to enlarge the slot cross section, and the depth is made deep too much, electrode thickness or the thickness of a separator 5 will become thick, and will become disadvantageous for a miniaturization from this viewpoint. Moreover, if the cross section of a slot is made small and the number of slots is made [many], the pressure loss of the oxidant gas in the gas supply slot 7 will become large, and it will become difficult to pass oxidant gas smoothly. Therefore, as width of face of a slot 7, about 0.2-2mm has about 0.5-20 desirablenmm as the depth of a slot 7 again. In addition, the configuration of these oxidant gas supply slot 7 shall be determined in consideration of the supply approach of the fuel gas mentioned later etc.

[0072] As mentioned above, the separator 5 in this example has the function as a channel to pass oxidizing agent gas. Thus, by using the components 5 (it being hereafter described as a channel combination separator) which have the function of both a separator and a channel, components mark can be reduced more and it becomes possible to attain a miniaturization further. In addition, it is also possible to replace with the above-mentioned separator 5 and to use the usual channel.

[0073] The channel combination separator 5 which was described above may be formed with a metal plate without a hole, and may be a porous body and just separates liquid fuel and oxidant gas. In addition, when using a porous body, it is desirable to close one [at least] hole of the field by the side of the fuel electrode of the channel combination separator 5 and the field by the side of an oxidizing agent pole so that liquid fuel may not trespass upon the oxidizing agent pole 3. Furthermore, in order to improve the flow of oxidizing agent gas, as for the aperture of the channel combination separator 5 which consists of a porous body, it is desirable to set up more greatly than the aperture of the porous body used as the oxidizing agent pole 3.

[0074] Furthermore, the form of the oxidant gas supply slot 7 can also use the channel combination separator 8 which bent and processed the metallic thin plate with a press, rolling, etc., as constraint is not received especially if conditions which were mentioned above are

satisfied, and shown in drawing 2. Such a separator 8 can establish the continuation slot 9 also in a fuel electrode 2 side while the oxidant gas supply slot 7 is established in the oxidizer pole 3 side. Moreover, while establishing the oxidant gas supply slot 7 in the channel combination separator 5 (8), it is also possible to establish the slot which passes oxidant gas perpendicularly also in the oxidizer pole 3.

[0075] The fuel installation way configuration member 11 is installed in at least one above-mentioned side face of a stack 6 so that the liquid fuel installation way 10 may be formed along this field. And the liquid fuel (mixed liquor object with the methanol which is usually an electrolyte and which serves as a dilute sulfuric acid and a fuel, for example) introduced in the above-mentioned liquid fuel installation way 10 is supplied to a fuel electrode 2 by capillary force from the side face of a stack 6. Here, if the liquid fuel installation way 10 is established in the upper part or the lower part of a stack 6 in case oxidant gas is passed toward the upper part from the lower part, the structure of a stack 6 will become very complicated. Therefore, it is important for it to prepare in the direction (the inside of drawing, x directions) which intersects perpendicularly with the flow of oxidant gas while forming the liquid fuel installation way 10 along either of four fields except a vertical side among the peripheral faces of a stack 6. Moreover, in order to supply the liquid fuel in the liquid fuel installation way 10 to a fuel electrode 2 from the side face of a stack 6 by capillary force, on the other hand (for example, side-face 4a), two side faces which consist of end faces of the electromotive section 4 among the four above-mentioned stack side faces meet at least, and the liquid fuel installation way 10 is formed. Namely, the above-mentioned liquid fuel installation way 10 is formed in the direction which intersects perpendicularly with the flow of oxidant gas along with at least one field 4a which is the field which consists of end faces of the electromotive section 4 among the peripheral faces of a stack 6, and a field containing the end face of a fuel electrode 2 when it puts in another way, and has been arranged at the flow of oxidant gas, and parallel. Moreover, in order to supply liquid fuel to a fuel electrode 2 by capillary force, liquid fuel introduced in the liquid fuel installation way 10 is considered as a configuration which contacts the above-mentioned electromotive section end-face 4a directly.

[0076] Without checking the flow of oxidant gas, the whole edge surface of a fuel electrode 2 can be made into the structure which touches liquid fuel, and these enable it to supply smoothly the liquid fuel in the liquid fuel installation way 10 to a fuel electrode 2 by capillary force. And since the fuel cell of this example is making the supply direction (the direction of z) of oxidant gas, and the introductory direction to stack 6 end face of liquid fuel intersect perpendicularly fundamentally, while it can simplify structure, there is little constraint on structure, and it becomes possible to miniaturize therefore.

[0077] in addition, the thing good also as as common as the bolting member of a stack 6 which it carries out and is established separately is also possible for the above-mentioned fuel installation way configuration member 11 -- etc. -- especially the configuration or ingredient are not limited. However, the part which touches stack 6 side face of the fuel installation way configuration member 11 must be insulated in order to prevent the short circuit between cells. This is performed by constituting for example, fuel installation way configuration member 11 the very thing from an insulating material, or making an insulating material intervene between the fuel installation way configuration member 11 and a stack 6.

[0078] Liquid fuel is introduced from the fuel storage tank with which the configuration of the liquid fuel installation way 10 mentioned above omitted illustration fundamentally, and this introduced liquid fuel should just be supplied to a fuel electrode 2 by capillary force. One of the

approaches of supplying liquid fuel to the liquid fuel installation way 10 from a fuel storage tank is made to carry out natural fall of the liquid fuel of a fuel storage tank, and the approach of introducing on the liquid fuel installation way 10 is in it. This approach can introduce liquid fuel into the liquid fuel installation way 10 certainly, if the constraint on the structure where a fuel storage tank must be formed in a location higher than the top face of a stack 6 is removed. The approach of being the capillary force of the liquid fuel installation way 10, and drawing liquid fuel from a fuel storage tank as other approaches, is mentioned. When according to this approach it becomes unnecessary to make higher than the top face of a stack 6 the location of the fuel inlet port established in the node 10 of a fuel storage tank and the liquid fuel installation way 10, i.e., a liquid fuel installation way, and it is combined with the above-mentioned natural falling method, there is an advantage that the installation of a fuel tank can be set up free.

[0079] Although it changes with the class of liquid fuel, or quality of the materials of the fuel installation way configuration member 11 in order to give capillary force to the liquid fuel installation way 10, it is desirable to set the clearance between the liquid fuel installation ways 10 (for t to show among drawing) to about 0.2-5mm. a possibility of producing the short supply of liquid fuel if the clearance t between the liquid fuel installation ways 10 is set to less than 0.2mm -- it is -- moreover -- If it exceeds 5mm, a possibility that sufficient capillary force may not be acquired will arise. Furthermore, when actuation of a cell is stopped for a long period of time, if vaporizing and becoming useless, the odor accompanying vaporization, etc. are taken into consideration, the smaller one is advantageous [the liquid fuel in the liquid fuel installation way 10 / the volume of the liquid fuel installation way 10]. Moreover, it also takes raising capillary force into consideration, and, as for the clearance t between the liquid fuel installation ways 10, it is more desirable to be referred to as 3mm or less.

[0080] However, in order to supply succeeding smoothly the liquid fuel introduced into the liquid fuel installation way 10 by capillary force to a fuel electrode 2 by capillary force, it is important to set up so that the capillary force to a fuel electrode 2 may become large from the capillary force of the liquid fuel installation way 10. Furthermore, in order to raise the capillary force of the liquid fuel installation way 10, an insulating porous body and fiber may be arranged to the interior. In this case, the clearance t between the above-mentioned liquid fuel installation ways 10 may exceed 5mm. In addition, it is not limited to one along the side face of a stack 6, and the number of the liquid fuel installation ways 10 can also form the liquid fuel installation way 10 also in the stack side face of another side.

[0081] Moreover, a fuel storage tank which was mentioned above can be made removable from a cell proper. It enables this to perform actuation of a cell continuously by exchanging a fuel storage tank for a long time. In this case, in order to operate equipment continuously also at the time of a changing battery, when a fuel storage tank is separated, the fuel needs to remain in the cell. Such a fuel stores dept. is a feed zone to the liquid fuel installation way 10 and a fuel electrode 2, or fuel electrode 2 the very thing, and considering the swap time of a fuel storage tank, as for the amount of the fuel which remains, it is desirable to make equipment into the amount which can operate 1 minute or more at least. Moreover, the supply of liquid fuel on the liquid fuel installation way 10 from a fuel storage tank is good also as a configuration which extrudes liquid fuel with natural fall which was mentioned above, the internal pressure in a tank, etc., and can also be considered as a configuration which pulls out a fuel by the capillary force of the liquid fuel installation way 10. In this case, when based on the internal pressure in natural fall or a tank, the outlet clearance between fuel storage tanks is not restrained in the clearance between the liquid fuel installation ways 10, but when based on capillary force, it is more

desirable than the clearance between the liquid fuel installation ways 10 to enlarge the outlet clearance between fuel storage tanks.

[0082] The liquid fuel introduced in the liquid fuel installation way 10 by approach which was mentioned above is supplied to a fuel electrode 2 by capillary force. As capillary force for drawing this liquid fuel in a fuel electrode 2 side, the capillary force of the porous body itself which serves as a fuel electrode 2 first is mentioned. When using such capillary force, while considering as the so-called continuation hole with which the hole of the fuel electrode 2 which is a porous body was made to connect and controlling the aperture, it becomes possible to supply liquid fuel by capillary force smoothly also in a longitudinal direction by considering as the free passage hole which continued from fuel electrode 2 side face by the side of the liquid fuel installation way 10 to at least other whole surface. Moreover, when cell area becomes large, since a cell reaction advances intensively by the entry side of liquid fuel, the speed of supply of liquid fuel not only becomes slow, but there is a possibility that the amount of supply of a fuel may decrease, so that it becomes far from the liquid fuel installation way 10. In such a case, it is effective to establish the liquid fuel installation way 10 also in the stack side of another side with which are satisfied of the conditions mentioned above.

[0083] The aperture of the porous body used as a fuel electrode 2 etc. is 0.2-300 micrometers, after taking into consideration the clearance between the liquid fuel installation ways 10 that what is necessary is just what can draw the liquid fuel in the liquid fuel installation way 10, although not limited especially. Considering as extent is desirable. Moreover, as for the volume of the hole used as the index of the continuity of the hole in a porous body, it is desirable to consider as about 35 - 80%. It is 0.2 micrometers about an aperture. If it is made small, manufacture of a fuel electrode 2 becomes difficult, and it is 300 micrometers. If it exceeds, capillary force will decline. Since the amount of a continuation hole will become less and the closed holes will increase in number if the volume of a hole becomes under 35 %, it becomes impossible moreover, to fully acquire capillary force. On the contrary, if the volume of a hole exceeds 80%, although the amount of a continuation hole will increase, manufacture becomes difficult while becoming weak in reinforcement. An aperture is 0.5-100 micrometers practical. As for the range and the volume of a hole, it is desirable to consider as 45 - 75% of range.

[0084] Moreover, in order to draw liquid fuel in a fuel electrode 2 by capillary force, it is desirable to open at least one of the side faces other than the side face by the side of the liquid fuel installation way 10 so that it may ***** with the liquid fuel with which the air in a fuel electrode 2 was drawn. However, as for side faces other than the field which the fuel electrode 2 described above, closing, when controlling volatilization of liquid fuel is desirable.

[0085] As liquid fuel is shown not only in the capillary force of the porous body itself which serves as the fuel electrode 2 mentioned above as capillary force for drawing in a fuel electrode 2 side but in drawing 3, it is also possible to constitute so that the liquid fuel supply slot 12 may be formed horizontally (the inside of drawing, the direction of y) as a continuation slot and liquid fuel may be drawn in a fuel electrode 2 side in the field which touches the fuel electrode 2 of the channel combination separator 5 using the capillary force of this liquid fuel supply slot 12. In this case, the liquid fuel installation way 10 shall be formed so that the open end section and liquid fuel of the liquid fuel supply slot 12 may touch directly at least. Moreover, it is also possible to use together the capillary force of the porous body itself used as the capillary force of the liquid fuel supply slot 12 and a fuel electrode 2.

[0086] Although the configuration of the above-mentioned liquid fuel supply slot 12 does not receive constraint especially if capillary force can be demonstrated, it needs to make capillary

force by the slot 12 at least smaller than the capillary force of a fuel electrode 2. Although the liquid fuel in the liquid fuel installation way 10 is supplied in the liquid fuel supply slot 12, it becomes impossible to supply it to a fuel electrode 2, if the capillary force of a slot 12 is larger than that of a fuel electrode 2. Although the configuration of the liquid fuel supply slot 12 changes with wettability of the component of the channel combination separator 5, and liquid fuel, as for the width of face, it is desirable to consider as the range of 0.2-10mm.

[0087] If the width of face of the liquid fuel supply slot 12 exceeds 10mm, capillary force will become small, the capillary force of a fuel electrode 2 will serve as a subject after all, and the semantics in which the liquid fuel supply slot 12 was formed will be lost. On the contrary, if the width of face of a slot 12 is set to less than 0.2mm, although capillary force will improve, a process that it is difficult for supply of liquid fuel to stop fulfilling a cell reaction upwards, and to cut a slot with the usual process and special is needed. The same is said of the depth of flute, and it is desirable to consider as the range of 0.1-2mm as the depth of flute. When the depth of a slot 12 is especially made deep too much, a thick kink colander will not be obtained for the thickness of the channel combination separator 5, but, as a result, a miniaturization will be checked.

Furthermore, since there is a possibility of it not only becoming useless, but vaporizing and emitting an odor in connection with vaporization when supply of a fuel is stopped, a generation of electrical energy is stopped and a lot of liquid fuel remains, as for the depth of flute, it is more desirable to be referred to as 1mm or less. Moreover, in order that the width of face of a slot may make [many] electric contact in addition to the same reason, it is more desirable to be referred to as 5mm or less, and it is 3mm or less desirably.

[0088] Moreover, when introducing liquid fuel into the liquid fuel installation way 10 by the capillary force from a fuel storage tank as mentioned above since it is what draws liquid fuel by the capillary force from the liquid fuel installation way 10, the above-mentioned liquid fuel supply slot 12 is set up so that the capillary force of the liquid fuel supply slot 12 may become large from the capillary force of the liquid fuel installation way 10. Although the difference of such capillary force is fundamentally decided with the cross section of the liquid fuel installation way 10 and the liquid fuel supply slot 12, and the component of a separator 5 and the ingredient of the fuel installation way configuration member 11, it is desirably more desirable than the clearance t between the liquid fuel installation ways 10 to make small either [at least] the width of face of the liquid fuel supply slot 12 or the depth. Thus, the configuration of the liquid fuel supply slot 12 shall be set up after taking into consideration the configuration of the porous body used as a fuel electrode 2, or the liquid fuel installation way 10. Moreover, as for the configuration of the liquid fuel supply slot 12, it is desirable to set up so that it is necessary to also take into consideration the configuration of the oxidant gas supply slot 7 for example, and the width of face and the depth of the oxidant gas supply slot 7 may become about 1.1 to 20 times from it of the liquid fuel supply slot 12. They are about 1.2 to 10 times still more desirably.

[0089] The above-mentioned liquid fuel supply slot 12 must not necessarily be formed horizontally, and may be leaned and formed in 45 - 90 degrees toward a perpendicular direction (the direction of z). However, the formation field of the liquid fuel supply slot 12 becomes narrow, and it is desirable [so effective fuel-supply ways], when an inclination becomes large to make it 30 or less degrees as an inclination in order to decrease in number. In addition, it is not this limitation when establishing the liquid fuel installation way 10 in both sides of a stack 6.

[0090] Thus, since a fuel can be supplied also to the longitudinal direction of a fuel electrode 2 through a slot 12 at coincidence while liquid fuel is supplied to a fuel electrode 2 from the whole edge surface of a fuel electrode 2 by establishing the liquid fuel supply slot 12 which extends

horizontally in the channel combination separator 5, it becomes possible to supply still more smoothly the liquid fuel in the liquid fuel installation way 10 to a fuel electrode 2. It becomes possible to advance a cell reaction to homogeneity all over electromotive section 4 by this, and a well head can be attained. In addition, although the above-mentioned example explained what formed both the oxidant gas supply slot 7 and the liquid fuel supply slot 12 in the channel combination separator 5, a channel may be separately installed to a fuel electrode 2 and the oxidizer pole 3. In such a case, the conductive plate which does not make gas penetrate is installed among both channels, or separation with liquid fuel and oxidant gas is aimed at by closing the hole of the field of one [at least] channel etc. However, in order to enable reduction of components mark, as a result much more miniaturization, it is desirable to make a channel serve a double purpose.

[0091] Moreover, in drawing liquid fuel in a fuel electrode 2 by capillary force from the liquid fuel installation way 10, the improvement in capillary force is important. Capillary force becomes so large that the clearance between capillary tube paths is small as mentioned above, and the wettability to the liquid fuel of a capillary tube path is large. Amelioration of the capillary tube section front face which causes capillary force from a viewpoint which enlarges wettability to the liquid fuel of a capillary tube path is effective, and it is effective to prepare an oxide skin especially in this front face. That is, it becomes remarkably large and the rate which draws liquid fuel in a cell not only becomes quick, but capillary force can extend the range of liquid fuel by preparing an oxide skin in the inside of the liquid fuel supply slot 12 established in the porous body internal surface and the channel combination separator 5 of a fuel electrode 2. Thereby, even if the area of a fuel cell is large, it not only can respond now, but it can shorten the duration at the time of starting a cell. However, as for the above-mentioned oxide skin, it is desirable to form so that the void content of a porous body may not be reduced. In the end face of the fuel electrode 2 which touches the liquid fuel installation way 10 especially, it is important to make it not plug up the inlet port of liquid fuel with formation of an oxide skin.

[0092] By the way, a fuel electrode 2 must conduct the electron generated as a result of the cell reaction. Therefore, the oxide skin prepared in fuel electrode 2 front face must not check the above-mentioned electronic conduction. If the oxide skin prepared in a fuel electrode 2 is insulation, an oxide skin will be formed except for the front face of the field in contact with the separator 5 of a fuel electrode 2, a channel, etc. Moreover, when preparing an oxide skin in the liquid fuel supply slot 12, it limits to the internal surface and an oxide skin is formed.

[0093] Moreover, when introducing liquid fuel to the liquid fuel installation way 10 by capillary force, formation of an oxide skin is effective also about the internal surface of the liquid fuel installation way 10.

[0094] The approach of raising temperature in an oxidizing atmosphere and a steam ambient atmosphere, and oxidizing a metal front face as the formation approach of such an oxide skin, the approach of processing with chemicals, such as alkali, etc. are mentioned. Moreover, removal of an oxide skin can perform the part by the mechanical approach, for example, polishing, cutting, etc.

[0095] In each above-mentioned example, although the fuel cell which has the stack 6 which carried out the laminating of the electromotive section 4 through the channel combination separator 5 was explained, in the fuel cell of this invention, neither a separator nor a channel is necessarily required. For example, as shown in [drawing 4](#), it is also possible to carry out direct two or more laminatings of the electromotive section 4 which pinched the electrolyte plate 1 on the fuel electrode 2 and the oxidizer pole 3, and to constitute a stack 13. Under the present

circumstances, as shown in drawing 4, the oxidant gas supply slot 7 is perpendicularly formed in the field adjacent to the oxidizer pole 3 of a fuel electrode 2 as a continuation slot, and as shown in drawing 5, it is perpendicularly formed in the field which touches the fuel electrode 2 of the oxidizer pole 3. Moreover, as shown in drawing 6, the oxidant gas supply slot 7 may be established in the field which touches the electrolyte plate 1 of the oxidizer pole 3. Furthermore, the oxidant gas supply slot 7 needs to be in contact with neither an electrolyte plate 1 nor a fuel electrode 2. Thus, oxidant gas can be smoothly passed also by forming the oxidant gas supply slot 7 in a fuel electrode 2 or the oxidizer pole 3 directly. In addition, the configuration of those other than these, i.e., liquid fuel installation way 10 grade, is considered as the same configuration as the fuel cell of the example mentioned above. And since components mark are more reducible by considering as the above-mentioned configuration, a miniaturization can be attained further.

[0096] Moreover, as described above, to consider as a configuration which a fuel electrode 2 and the oxidizer pole 3 meet with directly, it is necessary to prevent that liquid fuel is drawn in the oxidizer pole 3 from a fuel electrode 2. When liquid fuel is drawn in the oxidizer pole 3, it is because oxidant gas stops being able to flow easily and a cell reaction will be checked. What is necessary is just to control the aperture of the porous body which serves as the oxidizer pole 3 fundamentally in magnitude which does not draw liquid fuel by capillarity as an approach of preventing invasion of liquid fuel to the above-mentioned oxidizer pole 3. However, the above-mentioned aperture may have to be made into magnitude which draws liquid fuel by capillarity depending on the device to apply. In such a case, what is necessary is just to close the hole of the field by the side of the oxidizer pole 3 of the porous body used as a fuel electrode 2 irrespective of in any the oxidant gas supply slot 7 shall be formed between the fuel electrode 2 or the oxidizer pole 3. However, although you may also close the hole of the field by the side of the fuel electrode 2 except the slot 7 of the oxidizer pole 3 when establishing the oxidant gas supply slot 7 in the oxidizer pole 3, it is desirable for there to be a possibility that liquid fuel may trespass upon the oxidizer pole 3 through the side face of the oxidant gas supply slot 7, and to close the hole of the contact surface with the fuel electrode 2 of the oxidizer pole 3 and the side face of the oxidant gas supply slot 7 in this case.

[0097] As an approach of closing the above-mentioned hole, make into the shape of a slurry the ingredient which does not check a flow with a fuel electrode 2 and the oxidizer pole 3, and it is applied, or polishing, grinding, etc. are processed on the field concerned, and melting, the approach of making it solidify, etc. are mentioned to the approach of closing a hole with the plastic deformation produced in a porous body in that case, and a pan in the field concerned by the electron beam or laser. Moreover, when forming the oxidant gas supply slot 7 in the oxidizer pole 3, it can prevent that liquid fuel trespasses upon the oxidizer pole 3 also by [which do not let liquid fuel pass to the interface of a fuel electrode 2 and the oxidizer pole 3] inserting conductive ingredients, such as a metal plate, for example.

[0098] By the way, each fuel cell of each above-mentioned example has structure which touches directly the edge of the oxidizer pole 3 and the edge of an electrolyte plate 1 whose liquid fuel in the liquid fuel installation way 10 is a porous body. When touching liquid fuel at the edge, liquid fuel is drawn in the oxidizer pole 3 by capillary force, and the drawn liquid fuel makes the path of oxidant gas blockaded, since especially the oxidizer pole 3 cannot supply gas to an electrolyte plate 1 if it is not a porous body. Therefore, liquid fuel needs to prevent entering from the edge of the oxidizer pole 3.

[0099] Prevention of invasion of liquid fuel to the oxidizer pole 3 should just control the aperture

of the porous body used as the oxidizer pole 3 fundamentally in magnitude which does not draw liquid fuel by capillary force. However, the above-mentioned aperture may have to be made into magnitude which draws liquid fuel by capillary force depending on the device to apply. Invasion prevention of the liquid fuel in such a case is performed by covering the field adjacent to the liquid fuel installation way 10 of closing the hole of the field by the side of the liquid fuel installation way 10 of the oxidizer pole 3 ****, or the oxidizer pole 3 by the seal member etc. As these concrete approaches, a side face is covered with plates, such as a metal, an inorganic substance, ceramics, and the organic substance, a foil, the film, etc., for example, or these approaches of applying independent or the end of composite powder in the shape of a slurry etc. are illustrated. Moreover, it is also possible to apply the approach of using the plastic deformation mentioned above, and melting and the approach of making it solidify.

[0100] Moreover, as an approach of covering the side face of the latter oxidizing agent pole 3 by the seal member, when using a separator 5, a channel, etc., as shown in [drawing 7](#), the approach whose seal member 14 is pinched with a fuel electrode 2 and the channel combination separator 5 is mentioned so that it may be located in the oxidizing agent pole 3 and the side face of an electrolyte plate 1. In this case, if the seal member 14 has electronic conduction nature, since the short circuit between fuel electrodes 2 will take place and an output will no longer be obtained, the seal member 14 is formed with an insulating ingredient. In addition, the seal member 14 must not necessarily be pinched between a fuel electrode 2 and the channel combination separator 5, and only the side face of inserting between fuel electrodes 2 **** or the oxidizer pole 3 can also pinch it.

[0101] Moreover, when using neither a separator nor a channel, as shown in [drawing 8](#), the side face of the oxidizer pole 3 can be covered by the seal member by pinching the seal member 14 same between fuel electrodes 2. Under the present circumstances, only the side face of the oxidizer pole 3 can also pinch the seal member 14.

[0102] By the way, in the stack 6 (13) which carried out the laminating of the electromotive section 4, in order to secure the electric contact between the electromotive sections 4, a stack 6 (13) must be bound tight. In this case, when putting in another way by constituting the above-mentioned seal member 14 from an ingredient which has rubber elasticity and the electromotive section 4 is bound tight, while being able to acquire certainly the electric contact described above when the seal member 14 pinched between electromotive section 4 components or the channel combination separator 5 (it is hereafter described as a stack component part) deformed in rubber elasticity, the seal effectiveness of liquid fuel can be acquired.

[0103] That is, if the thickness of this rigid-body ingredient is thinner than the thickness of the stack component part covered by that cause when it is the rigid-body ingredient which the ingredient inserted between stack component parts does not deform, since a clearance will be made between a stack component part and a rigid-body ingredient, the seal of liquid fuel is not made. If the thickness of a rigid-body ingredient is thicker than the thickness of the stack component part covered by that cause, a clearance will be made between the oxidizer pole 3 or electrolyte plate 1 grade, and it will become impossible on the contrary, to secure electric contact, even if it binds a stack 6 (13) tight. Although coexistence of the seal of electric contact and liquid fuel is possible if the above-mentioned thickness is the same theoretically, it is difficult to make thickness of electromotive section 4 components regularity strictly in fact.

[0104] On the other hand, when a stack 6 (13) is bound tight, the difference of the thickness of a stack component part and the thickness of the seal member 14 can be made to absorb by deformation of the seal member 14 by giving rubber elasticity to the seal member 14 pinched

between stack component parts. It enables this to obtain the seal nature of electric contact and liquid fuel certainly. As a rubber elasticity ingredient, if crude rubber, the rubber made from Teflon, etc. demonstrate rubber elasticity, they can use various ingredients, for example.

[0105] Moreover, as mentioned above, when pinching the seal member 14 between stack component parts, in order to prevent still more certainly invasion of liquid fuel to the oxidizer pole 3, as shown in drawing 9, it is effective to consider as a configuration which a clearance 15 is formed between the oxidizer pole 3 and the seal member 14, and the seal member 14 and the oxidizer pole 3 do not meet with directly. Thereby, also when liquid fuel should leak from the fault section of a seal, it can avoid that liquid fuel is drawn in the direct oxidizer pole 3. Furthermore, in order to ensure mixing prevention to the oxidizer pole 3 of liquid fuel, it is closing the hole of the side face of the oxidizer pole 3.

[0106] In addition, the side face of the liquid fuel installation way 10 and the opposite side of the oxidizer pole 3 does not necessarily need to prepare the seal member which has rubber elasticity, and may make a part of insulating cell receipt member serve a double purpose as a sealant. In this case, it is desirable to prepare a clearance between the edge of the oxidizer pole 3 and a cell receipt member at least from a viewpoint which prevents invasion of liquid fuel to the oxidizer pole 3.

[0107] By the way, in drawing 1 thru/or drawing 9, although the case where the fuel electrode 2, the electrolyte plate 1, and the oxidizer pole 3 had touched at the flat surface was shown, in order to enlarge cell area, it is good also considering each contact surface as the shape of a curve. The case where the contact surface of a fuel electrode 2 and an electrolyte plate 1 is wavelike is shown in drawing 10. Although the wavelike side should just be formed in either [at least] the contact surface of a fuel electrode 2 and an electrolyte plate 1, or the contact surface of the oxidizer pole 3 and an electrolyte plate 1, it is more desirable that the contact surface of a fuel electrode 2 and an electrolyte plate 1 is carrying out the wave from a viewpoint of a cell reaction.

[0108] Moreover, the carbon dioxide produced by the decomposition reaction of the liquid fuel in a fuel electrode can be made to discharge efficiently in the fuel cell of this invention by establishing the slot on vertical in the field which touches the electrolyte plate of a fuel electrode further.

[0109] In the fuel cell of this invention, as mentioned above, a stack 6 (13) must be bound tight in order to secure the electric contact between the electromotive sections 4. It is also possible to also apply the same approach as the conventional fuel cell to this bolting and to consider as a configuration which is bound tight by the cell bolting member 17 formed with the ingredient which shows insulation for a stack 16 and has rubber elasticity as shown in drawing 11, although it is possible. By using such a cell bolting member 17, it becomes possible easily and to ensure bolting of a stack 16.

[0110] As described above, in case the cell bolting member 17 is used, a dimension is made smaller outside a stack 16 than a dimension in order to bind a stack 16 tight. And after extending the cell bolting member 17 and inserting a stack 16 into it, the force which has extended the cell bolting member 17 is released, and a stack 16 is bound tight by the stability of a rubber elasticity ingredient. In this case, as shown in drawing 11, the liquid fuel installation way 10 may be established in the cell bolting member 17, and its cell bolting member 17 is possible also for forming as another components.

[0111] By the way, the cell bolting member 17 formed with the ingredient in which the above-mentioned rubber elasticity is shown can be used not only for a methanol fuel cell but for various kinds of fuel cells shown in each above-mentioned example. However, it becomes a usage

condition that the heat-resistant temperature of a rubber elasticity ingredient is more than an operating temperature of a fuel cell. When using a common heat-resistant rubber ingredient from such a thing, it is possible to apply to phosphoric acid fuel cells including the methanol fuel cell mentioned above, a solid-state polyelectrolyte mold fuel cell, an alkaline electrolytic-solution mold fuel cell, a hydrazine fuel cell, etc. Moreover, as an ingredient in which rubber elasticity is shown, it is possible not only various kinds of rubber but to use a metal spring etc. In such a case, it is applicable to a fused carbonate fuel cell, a solid oxide fuel cell, etc.

[0112] In applying the cell bolting member formed with the ingredient in which the rubber elasticity mentioned above is shown to a general fuel cell. For example, the electrolyte plate pinched by a fuel electrode, an oxidizer pole, and these two electrodes as shown in [drawing 12](#), it binds tight with the cell bolting components 19 formed with the ingredient in which rubber elasticity is shown like the example which mentioned above the perimeter of the stack 18 which carried out two or more laminations of the electromotive section (cel) which furthermore has a gas channel if needed through the separator if needed.

[0113] Although [drawing 12](#) showed the example bound tight from four perimeters of a stack 18 to homogeneity with the cell bolting components 19, the bolting force should just be the configuration that it is added in the direction of a laminating of a stack 18 at least. Namely, the original purpose which binds a stack 18 tight improved contact between each cell component, and since it is in making small the electric resistance resulting from the contact resistance between components as much as possible, the bolting force should just be added in the direction of a laminating of a stack 18 at least. Then, as shown in [drawing 13](#), it is also possible to use the cell bolting components 20 grade which prepared rubber elasticity components 20a in the direction of a laminating of a stack 18.

[0114] As shown in [drawing 12](#), the cell bolting components 19 function all the peripheral faces of a stack 18 on a wrap case also as a heat insulator with a rubber elasticity ingredient. Moreover, as shown in [drawing 13](#), the heat which was produced from the open section 20b in the cell reaction in the case of the cell bolting components 20 which open a part of side face of a stack 18 can be missed outside. When it can choose according to the use gestalt of a fuel cell, for example, improvement in early availability is aimed at, or when the heat dissipation from a fuel cell does a bad influence to surrounding components etc., the cell bolting components 19 as shown in [drawing 12](#) are suitable for these. Moreover, when too much accumulation has a bad influence on a fuel cell, the cell bolting components 20 as shown in [drawing 13](#) are suitable. In addition, when using the cell bolting components 19 as shown in [drawing 12](#), it can also be used separately, being able to prepare the cooler style of a fuel cell.

[0115] Moreover, if the bolting force of the direction of a field of a stack 18 is too large when using the cell bolting components 19 and 20 shown in [drawing 12](#) or [drawing 13](#), too much force may join the corner of a stack 18, and a corner may receive damage. For this reason, although it is necessary to bind tight in the range which is the force to the direction of a field of a stack 18 fundamentally, and a corner does not damage, and to adjust the force, after covering the corner of a stack 18 with a rigid ingredient, it is desirable to bind tight with the cell bolting components 19 and 20. As especially shown in [drawing 14](#), it can decrease from a stack 18 even to extent which can disregard most force concerning each corner 18a of SUTTAKU 18 by installing the rigid member 21 of a large area in the both-ends side of the direction of a laminating of a stack 18, and binding it tight from on the with the cell bolting components 19 (20) which consist of a rubber elasticity ingredient. In addition, in the case of structure which a rigid ingredient makes short-circuit between cels (for example, the case of the structure inserted

in so that a rigid ingredient might surround the corner of a stack 18), it is necessary to aim at an insulation between SUTTAKU 18. However, when using a rigid ingredient also [plate / electric / ejection], it is desirable that it is a conductive single plate.

[0116] As structure of cell bolting components, what [not only] was shown in drawing 12 or drawing 13 but the thing for which cell bolting components are constituted combining a rubber elasticity ingredient and a rigid ingredient as are mentioned above and the direction of a laminating of a stack is shown in drawing 15 or drawing 16 at least that what is necessary is just the structure bound tight with rubber elasticity is possible.

[0117] Drawing 15 arranges the rigid member 22 to the both-ends side of the direction of a laminating of a stack 18, respectively, and it shows the structure which bound the stack 18 tight in the direction of a laminating while it connects between these rigidity members 22 with the rubber elasticity components 23 which cover the side face of a stack 18. Moreover, drawing 16 arranges the rigid member 22 to the both-ends side of the direction of a laminating of a stack 18, respectively, and shows the structure which bound the perimeter including these rigidity member 22 tight with the band-like rubber elasticity components 24. Thus, various kinds of combination can be used for the combination of a rubber elasticity ingredient and a rigid ingredient at least that the direction of a laminating of a stack should just be bound tight with rubber elasticity.

[0118] As long as a stack 18 is an external manifold type, you may bind tight from a manifold various kinds of cell bolting components which were mentioned above. In this case, as shown in drawing 11, some cell bolting components can also be used also [manifold].

[0119] Moreover, in order to bind a stack tight, when bolting [it is necessary to make the inside dimension method corresponding to the direction of a laminating of a stack at least smaller than the dimension outside the direction of a laminating of a stack and] actually, after various kinds of cell bolting components mentioned above once open cell bolting components and insert a stack into it, they must release the force which has opened cell bolting components. Under the present circumstances, in order to make it easy to open cell bolting components and to release the force after stack insertion, as shown in drawing 17, it is desirable to prepare notching 25a for extending in inside 4 corner of the cell bolting components 25. After inserting the rod for opening the cell bolting components 25 in notching 25a of the four above-mentioned corners and releasing the force, it becomes possible by drawing out a rod to bind a stack tight easily. Moreover, as shown in drawing 14, the rigid member 21 of a large area is installed in a both-ends side from a stack 18, and release of the force can also be made easy while opening the cell bolting components 19 using the space formed between the cell bolting components 19 and a stack 18.

[0120] In addition, if the bolting force required for the direction of a laminating of a stack is acquired as a rubber elasticity ingredient used for the cell bolting components mentioned above while having insulation, various rubber ingredients can be used, for example, crude rubber and the rubber made from Teflon will be illustrated. Moreover, the rubber ingredient which has thermal resistance, acid resistance, and alkali resistance is used according to the class of fuel cell.

[0121] Since a bolting activity becomes easy and small [of the bolting components itself] and lightweight-ization can be attained compared with the conventional bolting method etc. by using the cell bolting components of a stack which bind the direction of a laminating tight at least with rubber elasticity which was mentioned above, it contributes to the miniaturization of a fuel cell greatly. Moreover, since the bolting force can be adjusted easily, the correspondence to various kinds of fuel cells is easy.

[0122] Moreover, it is desirable [as mentioned above, it is not limited to the existence of the

catalyst bed in a fuel electrode 2 and the oxidizer pole 3 etc., but] to raise migratory [of the proton to generate] while it raises the effectiveness of the oxidation reaction by the side of a fuel electrode 2, since the fuel cell of this invention is a configuration which supplies liquid fuel to a fuel electrode 2 by capillary force. The approach of constituting from a fuel oxidation catalyst particle which made the fuel oxidation catalyst exist in island shape as an approach of filling such a demand for example without lapping a fuel electrode 2 in general mutually on the support of heat-resistant acid resistance, and made the proton conductivity matter of heat-resistant acid resistance exist in the front face of a fuel oxidation catalyst at least is mentioned.

[0123] As the example (a) of a fuel oxidation catalyst particle which was mentioned above Fuel oxidation catalyst particle which the fuel oxidation catalyst was made to exist in island shape without lapping in general mutually on the support of heat-resistant acid resistance, and covered the front face of this fuel oxidation catalyst with the proton conductivity thin film of heat-resistant acid resistance at least.

[0124] (b) A fuel oxidation catalyst is made to exist in island shape without lapping in general mutually on the support of heat-resistant acid resistance, and the fuel oxidation catalyst particle covered with the thin film which made the proton conductivity matter hold in the macromolecule network which has heat-resistant acid resistance for the front face of this fuel oxidation catalyst at least is illustrated.

[0125] Above (a) It reaches. Fundamentally also in any of (b), a fuel electrode 2 is constituted by the porous body of support which consists of a carbon particle which supported the fuel oxidation catalyst, Ti carbide, etc. The porous body held by hydrophobic resin bond agent like polytetrafluoroethylene constitutes the fuel oxidation catalyst particle which specifically consists of support which supported the above-mentioned fuel oxidation catalyst. And the above-mentioned fuel oxidation catalyst particle describes above. (a) It reaches. It is covered with one thin film of the (b). As the above-mentioned fuel oxidation catalyst, a Pt-Ru alloy, a Pt-Au alloy, a Pt-Sn alloy, a Pt-Re alloy, a Pt-Mo alloy, a Pt-Ti alloy, etc. can be used with platinum metals, such as a precious metal catalyst, for example, Pt, Pd, etc.

[0126] Above As shown in drawing 18 , on the front face of the support particle 26 which consists of a conductive particle which has heat-resistant acid resistance, such as a carbon particle and Ti carbide, the fuel oxidation catalyst particle of (a) makes the fuel oxidation catalyst 27 which was described above exist in island shape, and covers the front face of this fuel oxidation catalyst 27 and the support particle 26 with the proton conductivity thin film 28 of heat-resistant acid resistance. If the front face of the fuel oxidation catalyst 27 is covered at least, effectiveness will be acquired, but as shown in drawing 18 , by covering the whole including the front face of the support particle 26 with the proton conductivity thin film 28, the proton conductivity thin film 28 can also prevent the corrosion of the support particle 26, and becomes possible [attaining reinforcement] .

[0127] If the above-mentioned proton conductivity thin film 28 is the ingredient of heat-resistant acid resistance, it will not ask an organic material and an inorganic material. Also in it, the ion-exchange resin which makes a frame the fluorine-containing giant molecule of an organic system, for example, perfluorocarbon sulfonic acid resin, is suitable. Moreover, the thickness of the proton conductivity thin film 28 is 1 micrometer. Considering as the following is desirable. If thickness is not much thick, a reaction may be checked conversely. The approach of solution-izing ion exchange resin which was described above as an approach of covering the front face of a fuel oxidation catalyst with a proton conductivity thin film, and covering this is common, and simple. It is 1 micrometer in thickness especially. The electrochemical coating method using the

solution-ized ion exchange resin is excellent as an approach of forming the following uniform thin films very thinly.

[0128] Moreover, the above The fuel oxidation catalyst particle of (b) is described above as shown in [drawing 19](#) . It covers with the thin film 31 which made the proton conductivity matter 30 hold in the macromolecule network 29 which has heat-resistant acid resistance for the front face of the fuel oxidation catalyst 27 which made island shape exist in the front face of the same support particle 26 as (a), and the support particle 26.

[0129] As the above-mentioned macromolecule network 29, while having heat-resistant acid resistance, if excelled in bonding strength with support or a fuel oxidation catalyst, various polymeric materials can be used. If bonding strength with support or a fuel oxidation catalyst is taken into consideration, the poly aniline especially by electrolytic polymerization, polypyrrole, polyphenylene sulfide, etc. are suitable. Moreover, the monomer and polymer which can use various ingredients if the proton conductivity matter 30 held all over this macromolecule network 29 is the ingredient of heat-resistant acid resistance, for example, have proton conductivity are used. As a proton conductivity monomer, for example Trifluoro methansulfonic acid, The derivative of fluorination sulfonic acids, such as tetrafluoro ethane disulfonic acid, $(\text{HO}) - \text{O} - \text{P}(\text{CF}_3)_2 - \text{O} - \text{P}(\text{CF}_3)_2 - \text{O} - \text{H}$ and $(\text{HO}) - \text{O} - \text{P}(\text{CF}_3)_2 - \text{O} - \text{P}(\text{CF}_3)_2 - \text{O} - \text{H}$ -- two etc. -- the derivative of fluorination diphosphoric acid -- $(\text{CF}_3)_2\text{P}(\text{O})\text{SO}_2\text{CH}_2\text{SO}_2\text{CF}_2\text{CF}_2\text{P}(\text{O})(\text{CF}_3)_2$ and $\text{CF}_3\text{SO}_2\text{NHSO}_2\text{C}$ four F9 etc. -- the derivative of a fluorination sulfonyl acid is illustrated. Moreover, as a proton conductivity polymer which has the same property, the ion-exchange resin which makes a frame the fluorine-containing giant molecule of an organic system, for example, perfluorocarbon sulfonic acid resin etc., is illustrated. In practice, Nafion 117 (a trade name, Du Pont make), the DOW film (a trade name, Dow Chemical Co. make), etc. are solution-ized, and it uses by making the polymer molecule contained in this hold to a macromolecule network.

[0130] It is desirable to use electrolytic polymerization as the formation approach of a thin film 31 of having held the proton conductivity matter 30 in such a macromolecule network 29, as mentioned above. For example, by the support which supports a fuel oxidation catalyst, a porous electrode base is produced, as one electrode of electrolytic polymerization, this is supplied in the electrolytic bath containing a macromolecule network ingredient and the proton conductivity matter, is energized between the above-mentioned electrode and a counter electrode, and electrolytic polymerization is performed. A macromolecule network is formed by this, incorporating the proton conductivity matter inside, and such matter is incorporated in an electrode base. The fuel oxidation catalyst front face on support is covered with such electrolytic polymerization with the thin film which holds the proton conductivity matter in a macromolecule network. Under the present circumstances, as for electrolytic polymerization, it is desirable to carry out by passing a pulse-like current. Thereby, it is mum of an electrode base. The macromolecule network which holds the proton conductivity matter efficiently in the micropore of order can be made to incorporate. In addition, it adds beforehand in the electrolyte of a fuel cell, and the proton conductivity matter can also be made to incorporate all over a macromolecule network at the time of a cell reaction. Moreover, with quantity of electricity to pass, thickness is controllable and is described above. It is desirable to suppose that it is comparable as the proton conductivity thin film 28 in (a). In the fuel cell using a fuel electrode which was mentioned above As shown in [drawing 20](#) , the thin film 31 which made the proton conductivity matter hold in the macromolecule network which has the proton conductivity thin film 28 of wrap heatproof acid resistance and heat-resistant acid resistance for the front face of the fuel oxidation catalyst 27 in a fuel electrode In order to function as a migration path of the

proton (H⁺) generated by oxidation reaction of liquid fuel, it can be efficient, the liquid fuel drawn in the fuel electrode by capillarity can be made to react, and it becomes possible to attain high performance-ization of a fuel electrode. Furthermore, existence of the proton in the thin film 28 which has proton conductivity, and 31 enables it to make a fuel for example, into a methanol + drainage system. Therefore, it becomes unnecessary to take into consideration the acid resistance of a fuel cell component, and contributes to cost reduction. Moreover, the life property of a component also improves. Furthermore, in water **** by which the thin films 28 and 31 which have proton conductivity are represented with Nafion 117, even if it supplies a fuel (for example, methanol + water or a dilute sulfuric acid) as a gas, fuel oxidation catalyst ability can be demonstrated by membranous absorptivity.

[0131] Next, the example and its evaluation result of the fuel cell which is the first of the purpose of this invention and which was simplified and miniaturized are described.

[0132] It produced in the way which shows below the liquid fuel cell which has the configuration shown in example 1 drawing 1 . First, an average aperture is 20 micrometers. An average aperture is 30 micrometers while using the porous body which is 60mmx50mm as a fuel electrode 2. The electrolyte plate 1 was pinched by these, using an isomorphism-like porous body as an oxidizer pole 3. Through the channel combination separator 5 made from a metal plate whose configurations of the oxidizing agent gas supply slot 7 are a depth of 0.7mm, and width of face of 10mm, the laminating of these was carried out so that the number of laminatings might be set to 10, and the stack 6 was produced. In addition, the abrasive paper polished and closed the hole of the field adjacent to the liquid fuel installation way 10 of the oxidizer pole 3. Moreover, the configuration of the liquid fuel installation way 10 was made into 1mm of clearances.

[0133] Thus, when the mixed liquor of a methanol and a dilute sulfuric acid was introduced into the obtained liquid fuel cell as liquid fuel, liquid fuel was able to be supplied all over fuel electrode 2, and air was also able to flow smoothly, and the cell reaction was able to be advanced good.

[0134] Moreover, when the oxide skin was prepared in the internal surface of the porous body used as a fuel electrode 2 and the fuel cell was produced similarly, liquid fuel could be supplied more smoothly and the cell reaction was able to be advanced still better.

[0135] The following trials were performed in order to measure improvement in the capillary force by formation of an oxide skin. As the clearance between both plates was set to 1mm in the copper plate of two sheets in which the oxide skin was formed on the front face, the simulation fuel installation way was produced, it was immersed into the methanol and this was compared with the case of a copper plate without an oxide skin. Consequently, in the copper plate which has an oxide skin, the rise height of a methanol became about 5 times of the rise height of a copper plate without an oxide skin. Moreover, when time amount until a methanol goes up to the same distance was measured, the copper plate which has an oxide skin was about 1 of copper plate without oxide skin/8. Next, an average aperture is 20 micrometers. After forming an oxide skin in the internal surface of a nickel porous body, the oxide skin of front faces other than a side face was removed by polishing, this was immersed into the methanol, and time amount until a methanol goes up to the height whose rise height of a methanol is 10mm was measured. Consequently, in nickel porous body which has an oxide skin, compared with nickel porous body without an oxide skin, it was about 3 times the rise height of this, and time amount was about 1/5. The above test result shows that formation of an oxide skin is effective in improvement in capillary force.

[0136] Furthermore, in the above-mentioned liquid fuel cell, as shown in drawing 9 , while having arranged the seal member 14 made of Teflon rubber with a thickness of 5mm between fuel electrodes 2, as shown in drawing 11 , the liquid fuel cell was similarly produced by the cell bolting member 17 made of rubber except binding a stack 6 (16) tight. When liquid fuel was similarly supplied to this liquid fuel cell, liquid fuel was not able to trespass upon the oxidizer pole 3, but the effectiveness of the seal member 14 was able to be checked. Moreover, there is also no slack between stack component parts, and the usefulness of the cell bolting member 17 has been checked.

[0137] In the example 2 above-mentioned example 1, the same liquid fuel cell (fuel cell shown in drawing 3) was produced except establishing the liquid fuel supply slot 12 with a depth [of 0.5mm], and a width of face of 0.5mm in the field by the side of the fuel electrode of the channel combination separator 5. When liquid fuel was similarly introduced to this liquid fuel cell, liquid fuel is smoothly supplied all over fuel electrode 2, and the cell reaction was able to be advanced good.

[0138] It produced in the way which shows below the liquid fuel cell which has the configuration shown in example 3 drawing 4 . First, an average aperture is 20 micrometers. While forming the oxidant gas supply slot 7 with a depth [of 0.7mm], and a width of face of 10mm in the porous body which is 60mmx50mm, the abrasive paper polished and closed the hole of a slot forming face, and it considered as the fuel electrode 2. Moreover, an average aperture is 30 micrometers. The abrasive paper polished and closed the hole of one side face of an isomorphism-like porous body, and it considered as the oxidizer pole 3. The electrolyte plate 1 was pinched by these, the laminating was carried out and the stack 13 was produced so that the number of laminatings might be set to 10. In addition, the configuration of the liquid fuel installation way 10 was made into 1.5mm of clearances.

[0139] Thus, when the mixed liquor of a methanol and a dilute sulfuric acid was introduced into the obtained liquid fuel cell as liquid fuel, liquid fuel was able to be supplied all over fuel electrode 2, and air was also able to flow smoothly, and the cell reaction was able to be advanced good.

[0140] Moreover, like the example 1, when the effectiveness of an oxide skin and the effectiveness of the seal member 14 were checked, the good result was obtained like the example 1. Furthermore, the same result was obtained, when the oxidant gas supply slot 7 was formed in the oxidizer pole 3 and the same liquid fuel cell (fuel cell shown in drawing 5) was produced.

[0141] Next, the example and its evaluation result of the fuel oxidation catalyst in this invention are explained.

[0142] The thing which made heat treated conductivity carbon black Vulcan XC-72R (a trade name, Cabot Corp. make) which has the specific surface area of 100 m² / g support a platinum catalyst 20% of the weight as a raw material of an example 4 fuel oxidation catalyst was prepared. The dilution Nafion solution (about 0.01 % of the weight of concentration) obtained by dialyzing the Nafion solution (the thing, about 5 % of the weight of concentration which melted Nafion 117 to the mixed solvent of lower alcohol and water) which made Nafion 117 (a trade name, Du Pont make) which is one of the perfluorocarbon sulfonic acid resin the shape of a solution on the front face of this fuel oxidation catalyst raw material is used, and it is about 1 micrometer of thickness. The proton conductivity thin film was formed (it is hereafter called a qualification catalyst).

[0143] The above-mentioned qualification catalyst was distributed with the supersonic wave in polytetrafluoroethylene drainage system suspension TFE-30 (a trade name, Du Pont make).

Next, 3 aluminum chlorides were added to this mixed suspension, and the condensation deposit of the floc was carried out. The mixed lump of the shape of cotton containing this qualification catalyst (it is 70% at dry weight criteria) and polytetrafluoroethylene was made to support on carbon paper, and was dried after the press, and it calcinated for 20 minutes at 300 degrees C among nitrogen, and considered as the electrode. the obtained electrode -- per [an electrode unit area (1cm²)] -- it adjusted so that 1.5mg platinum might be included.

[0144] Thus, the fuel electrode half cell property was measured at 60 degrees C by using as liquid fuel the water solution which added the one-mol methanol to the one-mol sulfuric acid, using the obtained fuel electrode. Consequently, the limiting current density of a fuel electrode is 100 mA/cm². It excelled in the polarization property and the highly efficient thing has been checked.

[0145] The fuel electrode was obtained like the example 4 except it, without covering the raw material of the same fuel oxidation catalyst as example of comparison 1 example 4 by the proton conductivity film, the place which measured the half cell property of the obtained fuel electrode like the example 4 -- the limiting current density of a fuel electrode -- 60 mA/cm² it was .

[0146] The same fuel oxidation catalyst as example 5 example 4 was prepared, and this fuel oxidation catalyst raw material was distributed with the supersonic wave in polytetrafluoroethylene drainage system suspension TFE-30 (a trade name, Du Pont make). Next, 3 aluminum chlorides were added to this mixed suspension, and the condensation deposit of the floc was carried out. The mixed lump of the shape of cotton containing this catalyst raw material (it is 70% at dry weight criteria) and polytetrafluoroethylene was made to support on carbon paper, and was dried after the press, and it calcinated for 20 minutes at 300 degrees C among nitrogen, and considered as the electrode base.

[0147] Next, according to the procedure shown below, electrolytic polymerization was performed using the above-mentioned electrode base, and the thin film with which the proton conductivity monomer was held in the macromolecule network was formed on the surface of the catalyst. In addition, trifluoro methansulfonic acid was used as a proton conductivity monomer, using the poly aniline as a macromolecule network. First, the counter electrode and the above-mentioned electrode base were thrown in as a working electrode in the cell which held the electrolytic polymerization liquid which consists of mixed liquor of aniline 1 mol / l, and trifluoro methansulfonic acid 2 mol / l. It is 2 mA/cm², keeping the temperature of electrolytic polymerization liquid at 0 degree C. It is 20 mA/cm² to the pan after energizing for 5 minutes by constant current. It energized for 10 minutes by constant current, and electrolytic polymerization was performed. Thus, the thin film with which trifluoro methansulfonic acid was held was formed on the surface of the catalyst all over the poly aniline network, and the electrode for fuel electrodes was obtained.

[0148] While using the electrode base produced like example 6 example 5, the thin film with which it replaced with the proton conductivity monomer of an example 5 in the macromolecule network, and the proton conductivity polymer was held was formed on the surface of the catalyst by the same electrolytic polymerization as an example 5. In addition, as a proton conductivity polymer, Nafion 117 (a trade name, Du Pont make) was used, using the poly aniline as a macromolecule network. The conditions of electrolytic polymerization presupposed that it is the same except changing trifluoro methansulfonic acid into Nafion 117. Thus, the thin film with which Nafion 117 was held was formed on the surface of the catalyst all over the poly aniline network, and the electrode for fuel electrodes was obtained.

[0149] The fuel electrode half cell property of the electrode of the example 5 acquired by the above and an example 6 was measured like the example 4, respectively. Consequently, for the

limiting current density of the fuel electrode of an example 5, the limiting current density of the fuel electrode of 102 mA/cm² and an example 6 is 95 mA/cm². Each was excellent in the polarization property and the highly efficient thing has been checked.

[0150] According to the procedure shown below, electrolytic polymerization was performed using the electrode base produced like example 7 example 5. In addition, the macromolecule network and the proton conductivity monomer were taken as an example 5 and this quality of the material. First, aniline 1 mol / l, and fluoroboric acid In the cell which held the electrolytic polymerization liquid which consists of two mols [/ mixed liquor l., the counter electrode and the above-mentioned electrode base were thrown in as a working electrode, and electrolytic polymerization was performed on the same conditions as an example 5. Thus, the poly aniline network film was formed on the surface of the catalyst.

[0151] thus, the water solution which added the one-mol methanol to the one-mol sulfuric acid, using the obtained fuel electrode -- trifluoro methansulfonic acid -- 1 vol% -- the fuel electrode half cel property was measured at 60 degrees C by using as liquid fuel what was added.

[0152] the water solution which added the one-mol methanol to the one-mol sulfuric acid while using the electrode produced like example 8 example 7 -- Nafion 117 -- 1 vol% -- the fuel electrode half cel property was measured at 60 degrees C by using as liquid fuel what was added.

[0153] the limiting current density of an example 7 and an example 8 -- swerving -- ** 98 mA/cm² and 93 mA/cm² it is -- all were excellent in the polarization property and the highly efficient thing has been checked.

[0154] Using the electrode base produced like example 9 example 5, according to the procedure shown below, the example 5 performed electrolytic polymerization, impressing a difference rectangular pulse current a little, and formed the thin film with which the proton conductivity monomer was held in the macromolecule network on the surface of the catalyst. In addition, trifluoro methansulfonic acid was used as a proton conductivity monomer, using the poly aniline as a macromolecule network. First, the counter electrode and the above-mentioned electrode base were thrown in as a working electrode in the cell which held the electrolytic polymerization liquid which consists of mixed liquor of aniline 1 mol / l, and trifluoro methansulfonic acid 2 mol / l. A rectangular pulse current is used keeping the temperature of electrolytic polymerization liquid at 0 degree C, and it is energization quantity of electricity of 5m. A coulomb / cm² Pulse electrolytic polymerization was performed. As conditions at this time, they are current density 5 mA/cm², pulse on time 5msec, and pulse off time 20msec (duty cycle: 0.2). Thus, the thin film with which trifluoro methansulfonic acid was held was formed on the surface of the catalyst all over the poly aniline network, and the electrode for fuel electrodes was obtained.

[0155] While using the electrode base produced like example 10 example 9, the thin film with which it replaced with the proton conductivity monomer of an example 9 in the macromolecule network, and the proton conductivity polymer was held was formed on the surface of the catalyst by the same electrolytic polymerization as an example 9. In addition, as a proton conductivity polymer, Nafion 117 (a trade name, Du Pont make) was used, using the poly aniline as a macromolecule network. The conditions of electrolytic polymerization presupposed that it is the same except changing trifluoro methansulfonic acid into Nafion 117. Thus, the thin film with which Nafion 117 was held was formed on the surface of the catalyst all over the poly aniline network, and the electrode for fuel electrodes was obtained.

[0156] the place which measured the fuel electrode half cel property of the electrode of the example 9 acquired by the above, and an example 10 like the example 4, respectively -- the

limiting current density of these fuel electrodes -- swerving -- ** 105 mA/cm² and 103 mA/cm² it is -- all were excellent in the polarization property and the highly efficient thing has been checked.

[0157] According to the procedure shown below, electrolytic polymerization was performed using the electrode base produced like example 11 example 5. In addition, the macromolecule network and the proton conductivity monomer were taken as an example 9 and this quality of the material. First, the counter electrode and the above-mentioned electrode base were thrown in as a working electrode in the cell which held the electrolytic polymerization liquid which consists of mixed liquor of aniline 1 mol / l, and fluoroboric acid 2 mol / l, and electrolytic polymerization was performed on the same conditions as an example 9. Thus, the poly aniline network film was formed on the surface of the catalyst.

[0158] thus, the water solution which added the one-mol methanol to the one-mol sulfuric acid, using the obtained electrode -- trifluoro methansulfonic acid -- 1 vol% -- the fuel electrode half cell property was measured at 60 degrees C by using as liquid fuel what was added. The property that this half cell property is almost equivalent to an example 7 was acquired.

[0159] the water solution which added the one-mol methanol to the one-mol sulfuric acid while using the electrode produced like example 12 example 11 -- Nafion 117 -- 1 vol% -- the fuel electrode half cell property was measured at 60 degrees C by using as liquid fuel what was added. The property that this half cell property is almost equivalent to an example 8 was acquired.

[0160] Liquid fuel and oxidant gas can be supplied smoothly, without using a pump, Blois, etc. according to the fuel cell of this invention, as explained above. Thereby, simplification of a system and the simplification of structure can be attained and it becomes possible to offer the small fuel cell made difficult therefore conventionally.

[0161] The embodiment of this invention about discharge of the water generated with actuation of the second of the purpose of this invention of a fuel cell is described below.

[0162] An example of a small fuel cell which was suitable for the invention in this application using the drawing is shown.

[0163] The perspective view showing an example of the structure of a small fuel cell is shown in drawing 21. It consists of a water recovery room 35 for making easy fundamentally recovery and diffusion of the body 32 of a fuel cell, and a fuel cartridge, 33 and the fuel diffusion room 34 and the generated water. Hereafter, these contents of a configuration are explained to a detail.

[0164] The perspective view of the body 32 of a fuel cell is shown in drawing 22. The body 32 of a fuel cell has the structure by which the laminating was carried out where the laminating of the generation-of-electrical-energy section of a fuel cell as shown in drawing 22 was carried out. it is shown in drawing 22 -- as -- the body 32 of a fuel cell -- an electrolyte 36, a fuel electrode 37, and the oxidizer pole 38 -- since -- the laminating of the becoming electromotive section is carried out, and each electromotive section has composition separated with the separator 39.

[0165] The oxidizer pole 38 consists of the porous body in order to absorb the generated water. Moreover, in order that a fuel electrode 37 may also supply a fuel without special power, it is desirable when considering as porous body structure and performing liquid fuel supply of a methanol etc. using capillarity miniaturizes a fuel cell.

[0166] Moreover, in drawing 21, 35 is a water recovery room, is a part to which that it is harder makes recovery of the generated water easy, and arranges a porous body (water recovery wick) in this.

[0167] The water recovery wick is prepared so that the oxidizer pole 38 may be touched. Moreover, as for the water recovery wick, the porous body with an average pole diameter

smaller than an oxidizer pole is used.

[0168] Fuel supply is performed using the fuel cartridge 33. The sectional view of the fuel cell shown in drawing 23 at drawing 21 is shown. A cartridge 33 can be divided into two rooms, the fuel storage space 40 and the water storage space 41, and the water generated from a fuel (water is included in coincidence by the need) and the body of a fuel cell, respectively can be put in. The porous body which consists of inorganic or organic fiber is beforehand put into the interior 41 of water storage space. When said wick of water recovery indoor 35 equips a fuel cartridge, it is made to touch the water maintenance wick of the water storage space 410 in a fuel cartridge. At this time, a water maintenance wick uses a porous body with an average pole diameter smaller than said water recovery wick.

[0169] Finally the water generated by taking such structure is collected to the fuel cartridge 33. Although the water recovery room 35 does not need to exist independently and it can also form into the structure of the body of a fuel cell, a water recovery wick needs to arrange in it even in this case.

[0170] It is desirable to make it the structure which it shows below in carrying out also about supply of a fuel using capillarity on the other hand. The fuel diffusion room 34 is established in the fuel installation side face of the body of a fuel cell, and the wick which consists of inorganic or organic fiber is put in into this. The wick is in contact with the fuel installation side of a fuel electrode, and once the fuel supplied from a fuel cartridge is supplied to the wick of this fuel diffusion room 34, it is distributed to a fuel electrode in an operation of a capillary tube. In addition, the fuel diffusion room 34 does not necessarily need to exist separately from the body of a fuel cell, and may be formed into the structure of the body of a fuel cell. Moreover, it is not necessary to necessarily arrange a fuel diffusion wick, and the fuel of a liquid condition may be directly sent to the fuel installation side of the body of a fuel cell.

[0171] As for a fuel cartridge which was mentioned above, it is desirable to consider as the structure in which wearing and desorption are free at the body of a fuel. When it equips, the fuel diffusion wick of a fuel diffusion room contacts fuel storage space, a fuel is supplied, and it considers as the structure where the water recovery wick of a water recovery room and the water maintenance wick of water storage space can contact coincidence. On the contrary, when desorption is carried out, it considers as the structure which those contact is broken off, a fuel distribution room and water recovery room side is intercepted a fuel cartridge side, and each can intercept with the external world.

[0172] The porous body (wick) used for supply of a fuel or recovery of water in the above forms has the structure of attracting a liquid, in the operation of a capillary tube, i.e., an operation of surface tension, at this time, is arranging each porous body so that the value of that average pole diameter may become small gradually toward the direction of liquid flow, and can make liquid flow smooth. The force in which that an average pole diameter becomes small pulls a liquid with surface tension so much becomes large. Therefore, if a porous body is arranged continuously and it is made for the average pole diameter of each porous body to become small gradually, a fluid will flow smoothly toward the direction.

[0173] In this case, it is related with a fuel-supply path, and is 100 micrometers about the average pole diameter of fuel diffusion wicks (inorganic, organic fiber, etc.). It is 30 micrometers about extent and a fuel electrode (metal porous bodies, such as nickel). It considers as extent. On the other hand, it is related with the recovery path of water and is 50 micrometers about the average pole diameter of an oxidizer pole (metal porous bodies, such as nickel). Considering as extent, water recovery wicks (inorganic, organic fiber, etc.) are 30 micrometers. It is what is

considered as extent, and a flow to the required direction can be smoothly performed about each fluid. The average pole diameter of these wicks is changeable suitably according to the engine performance of the fuel cell which should be made to hold.

[0174] Moreover, as for the porosity of a porous body, it is desirable at this time to arrange so that it may become large gradually toward the flow direction of a fluid. If porosity becomes large, the volume of the fluid which can be held in porosity increases and passing speed of a fluid can be made prompt. However, it is related with a porous body and an average pole diameter (D), specific surface area (Sp), and porosity (E) are $D=(1/Sp) - (4E/(1-E))$.

It is in ***** and it is necessary to select the specific surface area and the porosity of the appearance and the porous body which fill the above-mentioned relational expression.

[0175] Although the small fuel cell which collects the collected water from an oxidizing agent pole in the water storage space in a fuel cartridge was shown in the example of a configuration of the above-mentioned above-mentioned fuel cell, the water collected depending on the case may be made to dissipate in the exterior of a fuel cell.

[0176] The perspective view showing an example of the configuration of the small fuel cell in the case of making the water collected from the oxidizer pole to drawing 24 dissipate outside is shown.

[0177] Specifically, it consists of the body 32 of a fuel cell, the fuel cartridge 33 and the water dissipation device 43, and the power machine 44 water recovery room 35 (not shown).

Moreover, the terminal 42 of the positive electrode of a pair and a negative electrode is arranged in the suitable location. The laminating of the g electromotive section which consists of the fuel electrode with which the body 32 of a fuel cell is shown in drawing 22, an oxidizer pole, and an electrolyte layer is carried out.

[0178] The water dissipation device 43 has contained the device for making the water generated on the oxidizer pole dissipate. The power machine 44 has contained the power machine for operating a water dissipation device, or the electronic circuitry. Drawing 25 shows the cross section at the time of disconnecting the fuel cell which looked at drawing 21 from the direction of the fuel cartridge 33 in the location where the body 1 of a fuel cell exists.

[0179] 4 is a water recovery room, is a part for making easy recovery and diffusion of the water generated on the oxidizer pole, and arranges a porous body (wick) in this. The water recovery wick is prepared so that an average pole diameter may be smaller than an oxidizer pole and the oxidizer pole in the body 32 of a fuel cell may be touched.

[0180] Both steam and water are contained and, as for the water sent to the water recovery room 35 shown in drawing 25, the abundance ratio changes with service conditions of a fuel cell. Since it dissipates as it is about a steam, it is satisfactory, and considering as the problem now generates with the gestalt of water. It is made for porosity to become 50% or more, and the porous body (water recovery wick) made to exist in the water recovery room 35 is made into the situation that the water captured between porosity according to the water diffusion device tends to dissipate.

[0181] As a dissipation device 43 of water, it has a small cross flow fan, and the approach of operating this and dissipating water can be applied.

[0182] Moreover, it may have the oscillating component which consists of a piezo electric crystal instead of a small cross flow fan, and generation water may be made to dispel by the vibration.

[0183] Moreover, prepare heater ability, some generation water is made to heat, volume expansion is carried out, thereby, a drain valve may be operated and the remaining generation

water may be made to discharge compulsorily.

[0184] Although the oscillating component which consists of a piezo electric crystal makes generation water dispel, since it is not made to evaporate, heat of vaporization is not needed. The oscillating component itself which consists of a piezo electric crystal can be extremely followed on a small thin shape. Therefore, the description that it is efficient small is not spoiled.

[0185] in the approach of making some generation water evaporating, as compared with making all evaporate, it is markedly alike, and ends with little energy.

[0186] Next, in order to be smoothly operated by the fuel cell of a configuration of having so far stated, the detailed structure of a desirable fuel electrode, an electrolyte layer, and an oxidizer pole is shown in drawing 26.

[0187] About a fuel electrode 37, the introductory field 45 of a fuel is made only into one side face among four side faces except the direction which carries out a stack, and forms two or more slots 46 for missing carbon dioxide gas towards the direction of the field which counters from this field from the middle on the fuel electrode 37 flat surface which touches the electrolyte layer 36. A fuel is smoothly carried with a capillary tube, and diffuses the inside of a porous body on the whole surface, and the carbon dioxide gas produced by the reaction is carried outside through a slot 46. In this case, in order that a fuel may prevent revealing to the exterior, the surface hole of other three side faces 47, 48, and 49 in which fuel supply is not performed is blockaded.

[0188] On the other hand, although the oxidizer pole 38 is also constituted from same porous body, it blockades completely and the hole of the front face of the side face 50 same in this case as the direction where the fuel of a fuel electrode is introduced prevents penetration of the fuel from this field. And two or more slots 51 are formed in the direction which goes to the oxidizer electrode face of the side which touches the electrolyte layer 36 direct, and the infeed of this slot is formed so that it may arrive up to three side faces 52, 53, and 54 other than the side face which blockaded the hole. These three side faces are for incorporating air, and actually incorporate air from two or more side faces before long at least. The water generated here on the oxidizer pole is missed from the field which blockaded the hole of a porous body, and the side face (54 [in this case]) of one *****. The structure which adopts air from three side faces is for raising the concentration of oxygen and gathering an oxidizer pole reaction rate later than a fuel electrode reaction.

[0189] In the above, the example of a small fuel cell including recovery of the water produced to the oxidizer pole of the invention in this application and discharge has been described. In the above-mentioned example, it has structure which all used the fuel cartridge for supply of the fuel to the body of a fuel cell, and was suitable for small and a pocket device.

[0190] To the electrical potential differences needed by the device differ and require a high electrical potential difference, it is necessary to make the number of the electromotive sections of the fuel cell which carries out a laminating increase. Or depending on a device, a fuel cell may not be substituted only for arrangement of an example from the demand to the configuration of a generation-of-electrical-energy object. In that case, as shown in drawing 27, it considers as the structure where the fuel-supply sides of the body 32 of a fuel cell gather, and the fuel diffusion room 34 there is installed in the perimeter of the stowed position of the fuel cartridge 33. By this, while the path of fuel supply becomes short, the distance from the water recovery room 35 also becomes near, and a reliable generation-of-electrical-energy object is acquired.

[0191] Without using special power according to the invention in this application, the water generated to oxidizer best quality is removed by whether you are Sumiya, and can make operation of a fuel cell maintain efficiently.

[0192] When especially a solid-state poly membrane is used as an electrolyte, operating temperature is 100 degrees C or less, and although the water to generate is almost liquid, according to this invention, especially the moisture of a liquid condition can be removed you to be Sumiya. Moreover, also when it moves [make / leaning a fuel cell, / it / reverse], scattering and a back flow of the once collected water can be prevented, and serves as small and a fuel cell for which it was suitable as a power source of a portable equipment.

[0193] Moreover, as mentioned above, since the fuel cell using the fuel-supply method which used the capillarity by the porous body also for supply of a fuel does not need power special to supply of a fuel, and discharge of water, the miniaturization of it is attained much more.

[0194] Invention for attaining the 3rd purpose of this invention It has the electromotive section which has the electrolyte layer pinched by a fuel electrode, an oxidizer pole, and these two electrodes. [whether two or more electromotive sections are connected to a serial, and a fuel is supplied from the fuel passage where the fuel electrode of each electromotive section is common, and the electrode surface of the fuel electrode of each electromotive section faces said fuel passage, and] Or it is the fuel cell of the structure where an oxidizer is supplied from the oxidizer passage where the oxidizer pole of each electromotive section is common, and the electrode surface of the oxidizer pole of each electromotive section faces said oxidizer passage, and is the fuel cell characterized by said electrolyte layer containing absorptivity or the water retention matter.

[0195] The block diagram of the fuel cell illustrated to drawing 28 explains below.

[0196] It has the electromotive section which has the electrolyte layer pinched by the fuel electrode concerning this invention, an oxidizer pole, and these two electrodes. [whether two or more electromotive sections are connected to a serial, and a fuel is supplied from the fuel passage where the fuel electrode of each electromotive section is common, and the electrode surface of the fuel electrode of each electromotive section faces said fuel passage, and] With or the fuel cell of the structure where an oxidizer is supplied from the oxidizer passage where the oxidizer pole of each electromotive section is common, and the electrode surface of the oxidizer pole of each electromotive section faces said oxidizer passage For example, the electromotive section 55 which is shown in drawing 28 and which consists of an oxidizer pole 38, a fuel electrode 37, and an electrolyte layer 60 like The structure linked to a serial is mentioned by connecting the fuel electrode 37 of the electromotive section 55 which arranged lining up side-by-side like, and adjoined each other which has a fuel electrode on the same side, and the oxidizer pole 38 with the conductor 57 for connection. In the cell of such structure, a fuel is supplied to the electrode surface of a fuel electrode 37 from the fuel passage 58 where both the electromotive section is common. Moreover, the air which is an oxidizer is supplied to the electrode surface of the oxidizer pole 38 from the oxidizer passage 59 common to both the electromotive section.

[0197] Moreover, in addition to this, the fuel cell of structure which connected the cylindrical electromotive section to the serial is mentioned. The cross-section block diagram of another fuel cell built over this invention at drawing 29 is shown. The electromotive section 55 is cylindrical and the fuel electrode 37 electrolyte layer 36 and the oxidizer pole 38 are formed from the cylindrical inside.

[0198] The one electromotive section 55 is repeatedly constituted so that the fuel electrode 37 which has the outside oxidizer pole 38 inside another electromotive section may be touched. In the fuel cell of such structure, a fuel is supplied to the fuel passage 58 formed inside cylindrical, and is supplied to the electrode surface of a fuel electrode 37. The air which is an oxidizer is

supplied to the oxidizer pole 38 from a cylindrical outside. Moreover, a fuel electrode is made into a cylindrical outside, an oxidizer pole is made into a cylindrical outside, and there is also structure which supplies a fuel from a cylindrical outside.

[0199] The perspective view of another fuel cell built over this invention at [drawing 44](#) is shown.

[0200] The one electromotive section 55 is cylindrical and the fuel electrode 37, the electrolyte layer 36, and the oxidizer pole 38 are formed from the cylindrical inside. Two or more electromotive sections 55 of the shape of such a cylinder are connected to the serial by the conductor 57 for connection. In the fuel cell of such structure, a fuel is supplied to the fuel passage 58 formed inside each electromotive cylinder-like section, and is supplied to the electrode surface of a fuel electrode 37. The air which is an oxidizer is supplied to oxidizer pole 38 front face from the oxidizer passage 59 common to each electromotive section of a cylindrical outside. Moreover, in the fuel cell of the structure which put the electromotive cylinder-like section in order in this way, a fuel electrode is made into the outside of this cylinder, an oxidizer pole is constituted so that it may become a cylindrical outside, and there is also structure which supplies a fuel from fuel passage common to each electromotive section of a cylindrical outside.

[0201] It is unescapable to make water and an electrolyte mix in reacting matter, such as a fuel conventionally supplied to a fuel electrode or an oxidizer supplied to an oxidizer pole, and in order to act as an electrolyte with which these serve as ionic conduction support, in the fuel cell of the usually above configurations, it has considered as what cannot remove the electrical-potential-difference loss between two or more electromotive sections, either.

[0202] It is characterized by using the thing which made the absorptivity or water retention matter which moisture is supplied and held [matter] in [other than the compound which has the ion exchange ability which is the quality of a main truss product of the usual electrolyte as an electrolyte layer of the electromotive section] the film , or may pass moisture according to a concentration gradient coexist in the invention in this application as a means to solve this problem .

[0203] A mimetic diagram explains the configuration and device of the electrolyte layer used for the fuel cell of this invention. The structure illustration of an electrolyte layer using the solid-state macromolecule of proton conductivity is shown in [drawing 30](#) . In [drawing 30](#) , as for the electrolyte layer 60, absorptivity or the water retention matter 62 is held in the solid-state polyelectrolyte 61.

[0204] The mimetic diagram of the mass transfer within this electrolyte is shown in [drawing 31](#) . The electrolyte layer which starts this invention so that clearly [in [drawing 31](#)] is maintained at the condition that the water generated on the oxidizer front face is absorbed promptly, and reacting matter can always be contacted at an electrode in order to show absorptivity thru/or water retention itself by work of absorptivity or the water retention matter, and the work which prevents desiccation on the inside of the film and the front face of a fuel electrode to coincidence also shows it while it shows the ion (proton) conductivity of solid polymer electrolyte original.

[0205] That is, the proton generated by the fuel electrode side is conveyed to a participating agent pole side (the direction of an arrow head 63) by the proton conductivity of a solid-state polyelectrolyte. Moreover, the water generated by the oxidizer pole side is sent by work of absorptivity or the water retention matter in a fuel electrode front face and an electrolyte like an arrow head 64, and moisture is held.

[0206] The electrolyte layer which starts this invention as mentioned above absorbs promptly the water generated on one electrode catalyst front face in order to show absorptivity thru/or water retention itself, both, the absorbed water for which a catalyst front face is maintained at the

condition that the active substance can always be contacted diffuses the inside of an electrolyte according to a concentration gradient, and the work which prevents desiccation of the electrode surface of another side also shows it. The outstanding property in which the electrolyte itself can furthermore maintain ionic dissociation effective have [no addition of the moisture from the outside] always and an ionic conduction property in this process is shown.

[0207] Therefore, in the fuel electrode using this electrolyte layer, since the water which could supply water into the electrolyte, without making water mix into the reacting matter to supply, and was produced on the oxidizer pole is absorbed by whether you are Sumiya, it can suppress ionic conduction other than an electrolyte layer small.

[0208] As the absorptivity concerning this invention, or water retention matter, gel compounds, such as water absorbing polymer compounds, such as starch, an acrylonitrile copolymer, bridge formation acrylate, and bridge formation polyethylene oxide, a silica hydrogel, and conversion protein (gelatin), etc. can be used.

[0209] Moreover, in the case of a solid-state polyelectrolyte, as an electrolyte, the remarkable effectiveness of the invention in this application is acquired.

[0210] As a solid-state polyelectrolyte, it is a perfluorocarbon-sulfonic-acid polymer (trade name: the cation exchange membrane of the polystyrene system which has a Nafion (U.S. Du Pont shrine make) sulfonic group is mentioned.) as a proton conductivity solid-state polyelectrolyte. By using such the electromotive section, the fuel cell which is the configuration of more than the amount of unescapable mixing having not contained the matter which acts as an electrolyte into any [of the reacting matter supplied to the oxidizer pole and fuel electrode which are the main point of this invention], and having connected the edge of two or more electromotive sections to the serial mutually is realizable.

[0211] Next, in order to prevent an approach, and mixing of reacting matter and the leakage current which carry out direct continuation of the charge collector of each generation-of-electrical-energy component with welding, electroconductive glue, etc. as an approach of connecting mutually the edge of two or more generation-of-electrical-energy components to a serial, in case the approach of connecting through an electric conduction plate etc. or the electromotive section is produced, the approach of making unify so that series connection may be carried out beforehand, and producing two or more electromotive sections etc. can be adopted.

[0212] Furthermore, in order to suppress the leakage of an electrolyte in these approaches, it is also effective to give the connection part of two or more electromotive sections a water-repellent finish.

[0213] Next, invention about the 4th of the purpose of this application is explained below. This invention supplies carbon content fuels, such as a methanol, to a fuel electrode directly. For example, it is for controlling poisoning on the front face of a fuel electrode which starts a methanol fuel cell, and is produced in a fuel electrode when [said] carbon content fuel supply is carried out.

[0214] Invention about the 4th purpose of this application is a fuel cell characterized by having the device to which polarization of the fuel electrode is carried out anodically in the fuel cell equipped with the electrolyte layer pinched by a fuel electrode, an oxidizer pole, and these two electrodes.

[0215] That is, in this invention, when the poisoning product on the front face of a fuel electrode is produced at the time of operation of a fuel cell, a counter electrode is connected to a fuel electrode, polarization is carried out anodically, and oxidation removal of said poisoning product is

carried out. It becomes the fuel cell with which the output which carried out long duration stability is obtained by that cause.

[0216] In the fuel cell, two or more electromotive sections which consist of a fuel electrode and an oxidizer pole electrolyte pole are further usually connected and used for the serial. In this case, it is desirable to carry out rotation of said polarization actuation for every generation-of-electrical-energy section, and to perform it. A poisoning product can be removed without interrupting operation.

[0217] An example is explained about the fuel cell of this invention which attains the 2nd, 3rd, and 4th purposes of this invention below.

[0218] The fuel cell ***** generation-of-electrical-energy object as shown in example 13 [drawing 24](#) was constituted. As rating, it considered as the capacity (60 Whs) of 10h by operating potential 3V6W. The number of the electromotive sections by which the laminating was carried out into the body of a fuel cell is eight. The structure of each electromotive section is as being shown in [drawing 22](#).

[0219] The solid-state polyelectrolyte 36 is 100 micrometers in thickness. Used trade name Nafion, the platinum catalyst was made to adhere to the front face of the both sides by the electroless deposition method, and optimum dose grant of the dispersion liquid of PTFE (Teflon) was carried out by the spray. The fuel electrode 37 and the oxidizer pole 38 of structure which are shown in [drawing 22](#) from the both sides are arranged, the fuel electrode 37 and the oxidizer pole 38 using the separator 39 which consists of a nickel plate use a porous body tabular [nickel], and, for a fuel electrode, pore volume distribution is 40-60 micrometers. It is in the range and is 50 micrometers at a median. It has the average pole diameter of extent. A cathode is 50 micrometers similarly. It has the average pole diameter of extent. In addition, the catalyst of platinum and PTFE of optimum dose were too given to the front face of the fuel electrode which touches a solid-state polyelectrolyte layer, and an oxidizer pole. The side face of the oxidizer pole in the same field as the field into which the fuel of a fuel electrode 37 is infiltrated, the solid-state polyelectrolyte film 36, and a separator 39 applies the protective coat of alcohol resistance (after blockading the hole of the field about an oxidizer pole), and it was made for alcohol not to invade from there. The sectional view of the fuel cell shown in [drawing 25](#) at [drawing 21](#) is shown.

[0220] The fuel diffusion room 34 is a product made of resin, and puts the fuel diffusion wick which consists of a resin fiber porous body (it is the particle of quality-of-the-material phenol resin, and the composite material of polyester cloth textile fabrics, and is the average pole diameter of 100 micrometers extent) into this interior. On the other hand, the water recovery room 35 inserts the water recovery wick of the resin porous body (average pole diameter of 40 micrometers extent, about 50% of porosity) of the same ingredient too. The cross flow fan was used as a water dissipation device 43.

[0221] Methanol:water =1:2 were put into the fuel cartridge by the number ratio of mols (water was made into the amount of double in order to hold a solid-state polyelectrolyte sentimentally, although it is 1:1 theoretically).

[0222] As an example 2 of example of comparison 2 comparison, the following generation-of-electrical-energy objects were constituted. That is, although it is the generation-of-electrical-energy object of the same configuration as an example 13, the average pole diameter of the oxidizer pole 38 and a water recovery wick is 50 micrometers too. The used fuel cell of structure was constituted.

[0223] As an example 3 of example of comparison 3 comparison, the following generation-of-

electrical-energy objects were constituted. That is, although it was the generation-of-electrical-energy object of the same configuration as an example 13, a different fuel cell in that a water recovery wick was not attached was constituted.

[0224] The result of having operated the above cell by 2A discharge in ordinary temperature is shown in drawing 32. In the example 2 of a comparison, and the example 3 of a comparison, discharge was completed for a short time and the property as rated did not come out. Since water piled up since the generated water was not removed from the body of a fuel cell quickly enough, and this prevented the consecutive reaction, it is considered.

[0225] In the example 13, discharge of rated ***** was possible to these. Although the electrical potential difference fell little by little during discharge, it was like [which is completely satisfactory]. Furthermore, all fuels all used it.

[0226] In addition, the ingredient stated in the above-mentioned example does not stop only at it, but many its ingredients are usable. For example, bulb metal ingredients, such as an alloy which used not only a nickel metal but an ingredient with acid resistance, for example, a stainless steel system ingredient, aluminum, or copper as the base or a tungsten, and titanium, are sufficient as the ingredient used for a fuel electrode or an oxidizer pole, and it should just be a porous body which consists of composite material, such as a carbon material or SiC, further. Or the ingredient which covered the front face of a resin porous body with the suitable acid-proof metal etc. is sufficient. In that case, as porosity, it is 1 to 100 micrometers as about 30 - 80%, and an average pole diameter. Extent is suitable, if it becomes below these lower limits -- parenchyma -- it becomes impossible to realize sufficient porosity and a liquid ceases to sink in. Moreover, if a upper limit is exceeded, the mechanical strength of an ingredient will fall, and the porosity itself becomes large too much, and the semantics as a liquid maintenance ingredient is lost.

[0227] Moreover, also about a wick, various things of the quality of the material are usable, and in order for the quality of the material of a hydrophilic property to carry a liquid in general, it is desirable. However, since it becomes the cause of short liquid junction or a short circuit in this case, there must not be no conductivity in the quality of the material. By resin, felt, such as phenol resin, polyester resin, and a natural cellulose, a nonwoven fabric, textile fabrics, etc. are desirable. As porosity, about 95% of an upper limit is [a minimum] desirable about 30% too.

[0228] The amount of liquid maintenance on parenchyma falls, and liquid holding power declines and it stops in this case, playing the role of a wick below at a lower limit above a upper limit.

[0229] The film was produced from the solution (Aldrich shrine make) of the solid-state polyelectrolyte film (trade name : Nafion: U.S. Du Pont shrine make) which consists of a perfluorocarbon-sulfonic-acid polymer of example 14 marketing, and the low-molecular-weight oligomer water solution of starch and a sodium polyacrylate polymer which is an absorptivity polymer. After film production mixed and developed both solutions on the glass plate so that a polyelectrolyte and an absorptivity polymer might become the solid content ratio 9:1, it was heat-treated and performed a conclusion and desiccation of a polymerization.

Thermocompression bonding of the nickel mesh was carried out as the catalyst bed and charge collector which become both sides of this film from the mixture of platinum support carbon powder and carbon fluoride, and it considered as the electromotive section.

[0230] In the example 14, these four electromotive sections were produced in dimension of 10cm and 3cm, each long edge side was connected through the nickel ribbon, and the generation-of-electrical-energy object of flat-surface 4 serial was produced. The facies of this generation-of-electrical-energy object are shown in drawing 33. In drawing 33, the electrolyte layer which a

fuel electrode becomes in 37 and an oxidizer pole and 60 become from a solid-state polyelectrolyte and an absorptivity polymer in 38, and 57 are conductors for connection which consist of a nickel ribbon. Drawing 34 is the sectional view showing the connection between the above-mentioned electromotive sections. For a fuel electrode and 38, as for an electrolyte layer and 56, in drawing 34, an oxidizer pole and 60 are [37 / a charge collector and 57] the conductors for connection. The connection part of a charge collector 56 and the conductor 57 for connection gave a water-repellent finish by applying and carrying out printing of the Teflon dispersion 65. The simulation fuel cell was manufactured using this generation-of-electrical-energy object. The mimetic diagram is shown in drawing 35. First, the above-mentioned generation-of-electrical-energy object 66 was contained in the simulation cel container 67, the air chamber 38 for supplying air and a fuel to electrode both sides, an air inlet 69, the air outlet 70 and the combustion chamber 71, the fuel inlet port 72, and the fuel outlet 73 were formed, and the simulation fuel cell was created. Air and a fuel were supplied to electrode both sides, and the generation-of-electrical-energy property was examined.

[0231] In the example 15 example 15, it gave a water-repellent finish by having been spreading - Burned and having carried out Teflon dispersion 65 all over the connection part between the electromotive sections of the generation-of-electrical-energy object produced like the example 13, and the simulation fuel cell was produced. The mimetic diagram of the connection part in this case is shown in drawing 36.

[0232] As shown in an example 16 and drawing 37, a nickel mesh was used in common between the two electromotive sections, and also the generation-of-electrical-energy object was made like the example 13, and this was made into the example 16.

[0233] Open circuit voltage and 0.2 A/cm² at the time of supplying hydrogen gas to the combustion chamber of the simulation fuel cell of examples 14-16, and supplying air to air above, The electrical potential difference at the time of energization is shown in Table 1.

[0234] The result of having supplied the hydrogen gas which the combustion chamber was made passing in 80-degree C warm water using the same simulation fuel cell as an example 8, and also having measured the electrical potential difference by the same approach as an example 13 is written together to Table 1 except an absorptivity polymer not being included in an example of comparison 4 solid-state polyelectrolyte.

[0235] The same generation-of-electrical-energy component as having used for example of comparison 5 examples 12-14 was cut in the dimension of 5cm.5cm, and it inserted with two porous sintering plates of nickel powder used as a positive/negative two-poles room. 4 sets of this were produced, on both sides of the nickel plate, the laminating was carried out in between [each], and the simulation fuel cell was produced. The electrical potential difference at the time of supplying hydrogen gas to a fuel electrode side, and supplying air to an oxidizer pole side also about this simulation fuel cell, is measured, and it is shown in Table 1.

[0236]

[Table 1]

番 号	開路電圧 (mV)	200 mA/cm ² 閉路電圧 (mV)
実施例 14	405	285
実施例 15	415	300
実施例 16	405	290
比較例 4	385	265
比較例 5	400	280

Moreover, the near dimension comparison about the simulation fuel cell of an example 14 and the example 4 of a comparison is performed, and a result is shown in Table 2.

[0237]

[Table 2]

番号	単位発電 素子面積 (cm ²)	200mA/cm ² 時 出力 (mW)	模擬燃料 電池体積 (cm ³)	発電素子面積 当りの体積 (cm)	出力当りの 体積 (cm ³ /W)
実施例 14	30	57	約 1.2	0.4	211
比較例 4	25	56	約 3.1	1.24	554

As mentioned above, even if the fuel cell of this invention carries out the laminating of the generation-of-electrical-energy section of the same number, it turns out that more advantageous in volume and small it is a high voltage than the case where the humid reacting matter which can serve as the ion source which has been performed the laminating approach of a conventional type like the example of a comparison or conventionally is supplied.

[0238] Furthermore, the electrical potential difference the case where supplied the methanol heated at 60 degrees C to the combustion chamber of the simulation fuel cell of an example 14, and direct conversion is performed, and at the time of adding the water of this volume to a methanol and performing the same generation of electrical energy is shown in Table 3.

[0239]

[Table 3]

供給燃料	開路電圧 (mV)	60 mA/cm ² 閉路電圧 (mV)
メタノール	2.80	1.65
メタノール+水(1:1)	2.70	1.50

As shown in Table 3, even when a fuel electrode methanol is supplied, it turns out that a fuel cell operates. Therefore, it is clear that the fuel cell's of this invention it is not necessary to supply the water leading to a loss of the electrical potential difference between each polar zone with a fuel, and an electrical-potential-difference loss can be reduced.

[0240] an example 17 -- the fuel cell first shown in drawing 38 was made as an experiment. The electromotive section 74 has structure which allotted the fuel electrode 76 and the oxidizer pole 77 on both sides of the solid-state polyelectrolyte 75, and has formed the combustion chamber 71

and the air chamber 68 in the outside further, respectively. Moreover, in the combustion chamber 71, the counter electrode 78 when carrying out polarization of the fuel electrode anodically is installed. Here, the perfluorocarbon-sulfonic-acid polymer (trade name : Nafion; U.S. Du pont shrine make) of marketing of platinum to a solid-state polyelectrolyte was altogether used for the fuel electrode, the oxidizing agent pole, and the counter electrode. As ANORAITO, the water solution of methanol 1mol / 1, and sulfuric-acid 1mol / 1 was used.

[0241] This cel is used and it is 20 mA/cm². The discharge property was investigated with current density. At this time, discharge was interrupted every 100 minutes, polarization actuation during a bond and 3 minutes was performed for the fuel electrode 76 and the counter electrode 78 to external DC power supply 79 of 2V, and the electrode was made to refresh.

[0242] As example of comparison 6 comparison, the discharge property was investigated also about what does not perform this polarization actuation.

[0243] A result is shown in drawing 39 . To output voltage declining and going with the passage of time, in the case of the example 5 which performed polarization actuation on the way, even if 1000 minute passes, high output voltage is maintained in the example 6 of a comparison which discharged continuously.

[0244] Example 18 The cell which carried out 10 cel laminating of the electromotive section of example of comparison 7 example 17 was made as an experiment. About this laminating cel, the discharge property was investigated on an example 17 and these conditions. However, in this case, only one removes refresh actuation from a discharge circuit, and it carried out polarization of the inside of each cel under discharge to the cel, and the remaining cels enable it to continue discharge, and carry out rotation of this actuation in each cel, and it was made for an output not to interrupt them. Moreover, the power source for polarization was taken from the cel which is carrying out the laminating, and was carried out as [use / the external power source]. The outline and circuit of a system are shown in drawing 40 . This drawing showed the example refreshed for No.3 cel. That is, since a switch (A) was switched in order to remove No.3 cel from a discharge circuit, and the fuel electrode of a cel was polarized further, the switch (B) was switched and juxtaposition was made to take and carry out fixed time amount polarization of the power source from the cel of No.4, No.5, and No.6 during discharge. And low TESHON of this switching actuation was carried out in each cel which carried out the laminating. Polarization was performed for 5 minutes for for [every] 100 minutes like the example 11. In addition, the switching circuit in a drawing destructive line frame can be summarized to an integrated circuit, and can be miniaturized.

[0245] Thus, the discharge property is shown in drawing 41 as the constituted cell and a comparison about (the example 7 of a comparison), and the thing which does not perform polarization actuation at all.

[0246] In an example 18 as well as an example 17, even if 1000 minute passes, high output voltage is maintained continuously.

[0247]

[Effect of the Invention] As explained in full detail above, according to the invention in this application, the efficient fuel cell suitable for a miniaturization can be offered.

[0248] That is, according to invention about the 2nd of the purpose of this application, the water produced on the oxidizer pole front face can be collected you to be Sumiya, without using special power. And since the back flow of the collected water, scattering, etc. do not arise even if it uses it as a power source of working, in order to absorb using a porous body, it is the structure for which it was suitable as a power source for small devices.

[0249] Moreover, according to invention about the 3rd of the purpose of this application, in the fuel cell of structures, such as a mold lining up side-by-side suitable for a miniaturization, and cylindrical, the loss of the electrical potential difference between the invention sections can decrease, and an efficient power source can be acquired.

[0250] Moreover, when the methanol fuel which was suitable as a fuel of a small fuel cell is used according to invention about the 4th of the purpose of this application, the fuel cell with which poisoning on the front face of a fuel is stopped, and the output which carried out long duration stability is obtained can be realized.

[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.

3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] the part which shows the important section configuration of the fuel cell which has a separator by one example of this invention -- a notching perspective view.

[Drawing 2] Drawing for explaining the modification of the channel combination separator shown in drawing 1.

[Drawing 3] the part which shows the important section configuration of other examples of the fuel cell which has the separator of this invention -- a notching perspective view.

[Drawing 4] the part which shows the important section configuration of the fuel cell which excluded the separator by one example of this invention -- a notching perspective view.

[Drawing 5] the part which shows the important section configuration of other examples of the fuel cell which excluded the separator of this invention -- a notching perspective view.

[Drawing 6] the part which shows the important section configuration of the example of further others of the fuel cell which excluded the separator of this invention -- a notching perspective view.

[Drawing 7] the part which shows the important section configuration of the modification of the fuel cell shown in drawing 3 -- a notching perspective view.

[Drawing 8] the part which shows the important section configuration of the modification of the fuel cell shown in drawing 4 -- a notching perspective view.

[Drawing 9] The sectional view showing the important section configuration of the example made to transform further the fuel cell shown in drawing 7.

[Drawing 10] the part which shows the important section configuration of the modification of the fuel cell of this invention -- a notching perspective view.

[Drawing 11] the part which shows the bolting structure of the fuel cell of this invention -- a notching perspective view.

[Drawing 12] Drawing showing typically the configuration of the fuel cell which has the bolting structure of this invention.

[Drawing 13] Drawing showing typically other examples of the bolting structure of the fuel cell by this invention.

[Drawing 14] Drawing showing the modification of the bolting structure of the fuel cell shown in drawing 12 and drawing 13.

[Drawing 15] Drawing showing the example of further others of the bolting structure of the fuel cell by this invention.

[Drawing 16] Drawing showing the example of further others of the bolting structure of the fuel cell by this invention.

[Drawing 17] Drawing showing the modification of cell bolting components.

[Drawing 18] The sectional view showing the important section configuration of an example of

the fuel oxidation catalyst particle in the fuel cell of this invention.

[Drawing 19] The sectional view showing the important section configuration of other examples of the fuel oxidation catalyst particle in the fuel cell of this invention.

[Drawing 20] The sectional view for explaining the electrode reaction in the fuel oxidation catalyst used for the fuel cell of this invention.

[Drawing 21] The perspective view showing the structure of a small fuel cell including the water recovery device of this invention.

[Drawing 22] The perspective view of the body of a fuel cell used for the small fuel cell of drawing 21.

[Drawing 23] The sectional view showing the configuration of the small fuel cell of drawing 21.

[Drawing 24] The perspective view showing the configuration of a small fuel cell including the recycled water dissipation device of this invention.

[Drawing 25] The sectional view seen from the direction according to configuration of the small fuel cell of drawing 21.

[Drawing 26] The perspective view showing the configuration of the fuel electrode of a small fuel cell including the water recovery device of this invention, an electrolyte layer, and an oxidizer pole.

[Drawing 27] The perspective view showing the configuration of a small fuel cell including the recycled water dissipation device of this invention.

[Drawing 28] The block diagram showing an example of the array configuration of the electromotive section of the fuel cell of this invention.

[Drawing 29] The block diagram showing an example of the array configuration of the electromotive section of the fuel cell of this invention.

[Drawing 30] The structure illustration of an electrolyte layer.

[Drawing 31] The mimetic diagram showing the mass transfer in an electrolyte layer.

[Drawing 32] The time amount-voltage characteristic Fig. of the fuel cell concerning the example 13 and the examples 3 and 4 of a comparison of this invention.

[Drawing 33] The schematic diagram of the generation-of-electrical-energy object concerning an example 14.

[Drawing 34] The schematic diagram of the connection part of the generation-of-electrical-energy object concerning an example 14.

[Drawing 35] The sectional view of the simulation fuel cell concerning an example 14.

[Drawing 36] The schematic diagram of the connection part of the generation-of-electrical-energy object concerning an example 15.

[Drawing 37] The schematic diagram of the connection part of the generation-of-electrical-energy object concerning an example 16.

[Drawing 38] The circuit diagram showing the configuration of the fuel cell concerning an example 17.

[Drawing 39] The time amount-voltage characteristic Fig. of the fuel cell concerning an example 17.

[Drawing 40] The circuit diagram showing the configuration of the fuel cell concerning an example 18.

[Drawing 41] The time amount-voltage characteristic Fig. of the fuel cell concerning an example 18.

[Drawing 42] The schematic diagram of the conventional fuel cell.

[Drawing 43] The perspective view showing the laminated structure of a fuel cell.

[Drawing 44] The block diagram showing an example of the array configuration of the electromotive section of the fuel cell of this invention.

[Translation done.]